European Aviation Safety Agency

Notice of Proposed Amendment 2014-23

Integrated Modular Avionics (IMA ETSO-2C153)

RMT.0456— 10.09.2014

EXECUTIVE SUMMARY

This Notice of Proposed Amendment (NPA) addresses safety and economic issues for Integrated Modular Avionics (IMA), which are spreading across new aircraft and which group, in lesser volume, functions common to different avionics. These functions span from rack housing to processing and data storage resources, as well as power supplies and interfaces.

The proposed ETSO-2C153 is different from the corresponding FAA TSO-153, since the latter does not contain minimum performance specifications for the various IMA modules.

The specific objective of the IMA Integrated Rulemaking Project is to ensure a cost-efficient and transparent certification process for IMA by:

a) offering to IMA manufacturers the possibility to obtain ETSO authorisations at platform/ module level, independent of aircraft (this NPA);

b) offering to integrators of aircraft functions on already authorised IMA platforms the possibility to obtain ETSO authorisations, independent of aircraft (RMT.0621 which would propose an amendment to CS-ETSO Subpart A); and

c) providing public guidance for incremental certification of IMA, starting with platform modules and culminating in their installation on aircraft, so covering all connected aspects (e.g. impact on Master Minimum Equipment List (MMEL)). To achieve this, RMT.0622, whose NPA is under development will propose the new AMC 20-170.

This NPA hence proposes to introduce a new ETSO-2C153 into Index 2 (i.e. significantly different from corresponding FAA provisions) of CS-ETSO.

Applicability		**Process map**	
Affected regulations and decisions:	CS-ETSO Subpart C (Decision 2003/10/RM of the Executive Director of 24 October 2003)	Terms of Reference	24.10.2013
		Concept Paper:	Yes (Appendix 1 issue 1 of ToR)
Affected stakeholders:	• Certification Authority (i.e. EASA for ETSO articles) • IMA System Integrator • Application Suppliers • Platform and Module suppliers	Rulemaking group:	No
		RIA type:	Light
		Technical consultation during NPA drafting:	Yes (initial drafting outsourced to ASD)
Driver/origin:	Level playing field	Duration of NPA consultation:	3 months
		Review group:	No
Reference:	Industry (ASD) comments to draft ToR RMT.0186 (ETSO.008)	Focussed consultation:	Yes (in a form depending on the comments received)
		Publication date of the Opinion:	N/A
		Publication date of the Decision (RMT.0456):	2016/Q1

Table of contents

1. Procedural information

1.1. The rule development procedure

The European Aviation Safety Agency (hereinafter referred to as the 'Agency') developed this Notice of Proposed Amendment (NPA) in line with Regulation (EC) No 216/2008[1] (hereinafter referred to as the 'Basic Regulation') and the Rulemaking Procedure[2].

This rulemaking activity is included in the Agency's Rulemaking Programme 2014-2017 under RMT.0456, which, together with RMT.0621 and RMT.0622, forms the integrated rulemaking project on Integrated Modular Avionics (IMA), whose ToR (Issue 2) were published on 24 October 2013[3].

The text of this NPA has been developed by the Agency based on the input kindly provided by the Aerospace and Defence Industry Association of Europe (ASD)[4]. It is hereby submitted for consultation of all interested parties[5].

The process map on the title page contains the major milestones of this rulemaking activity to date and provides an outlook of the timescale of the next steps.

1.2. The structure of this NPA and related documents

Chapter 1 of this NPA contains the procedural information related to this task.

Chapter 2 (Explanatory Note) summarises the core technical content.

Chapter 3 contains the proposed text for the new ETSO-2C153: any suggestion to improve the text of the proposed new technical requirements would be welcomed.

Finally, Chapter 4 contains the Regulatory Impact Assessment (RIA) showing which options were considered and what impacts were identified, thereby providing the detailed justification for this NPA. The RIA will not be republished, so minor comments (e.g. editorial changes) on it are not necessary. Only comments which may change the recommended option might have an effect.

---

1 Regulation (EC) No 216/2008 of the European Parliament and the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC (OJ L 79, 19.3.2008, p. 1), as last amended by Commission Regulation (EU) No 6/2013 of 8 January 2013 (OJ L 4, 9.1.2013, p. 34).

2 The Agency is bound to follow a structured rulemaking process as required by Article 52(1) of the Basic Regulation. Such process has been adopted by the Agency's Management Board and is referred to as the 'Rulemaking Procedure'. See Management Board Decision concerning the procedure to be applied by the Agency for the issuing of Opinions, Certification Specifications and Guidance Material (Rulemaking Procedure), EASA MB Decision No 01-2012 of 13 March 2012.

3 http://easa.europa.eu/system/files/dfu/ToR%20RMT.0456%20and%200621%20and%200622%20Issue%202.pdf.

4 http://www.google.de/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=1&cad=rja&uact=8&ved=0CCAQFjAA&url=http%3A%2F%2Fwww.asd-europe.org%2F&ei=WW_LU8SqNsTvOuulgagP&usg=AFQjCNEgSf7WWFyZ6nzwTmFJCd-56NvN9g&bvm=bv.71198958,d.bGE.

5 In accordance with Article 52 of the Basic Regulation and Articles 5(3) and 6 of the Rulemaking Procedure.

1.3. How to comment on this NPA

Please submit your comments using the automated **Comment-Response Tool (CRT)** available at **http://hub.easa.europa.eu/crt/**[6].

The deadline for submission of comments is **10 December 2014.**

1.4. The next steps in the procedure

Following the closing of the NPA public consultation period, the Agency will review all comments and perform a focussed consultation. As a minimum, the focused consultation will consist of a project meeting between ASD and Agency's experts. A wider focused consultation may be considered, based on the number and content of comments and on the number of commentators.

The outcome of the NPA public consultation as well as of the focussed consultation will be reflected in the respective Comment-Response Document (CRD).

The Agency will publish the CRD simultaneously with the Decision introducing ETSO-2C153 into CS-ETSO.

[6] In case of technical problems, please contact the CRT webmaster (crt@easa.europa.eu).

2. Explanatory Note

2.1. Overview of the issues to be addressed

2.1.1 The use of Integrated Modular Avionics (IMA) has rapidly expanded in the last two decades and it is expected to progress even more in the future. Today IMA can be found in all classes of aircraft, including the types certified by the Agency. IMA is a shared set of flexible, reusable and interoperable hardware and software resources that, when integrated, form a 'system' that provides computing resources and services, designed and verified to meet a defined set of functional, safety and performance requirements, and to host applications performing aircraft functions. In other words, IMA architecture integrates several aircraft functions on the same platform, provided to different hosted applications. These functions (e.g. power supply) historically had been contained in functionally and physically separated 'boxes' or Line Replaceable Units (LRUs), in the end increasing the total volume and mass.

2.1.2 From a regulatory perspective, there are no specific requirements within the current EASA Certification Specifications (CS including CS-ETSO) or AMC-20 series for the certification aspects of IMA. Additional guidance is hence needed to address specific aspects at the:

(a) platform level (i.e. design and production of the IMA platform integrating hardware and software, but not yet applications performing aircraft functions, as covered by this NPA (RMT.0456);

(b) system level (i.e. when applications performing aircraft functions are integrated on the IMA platform, but not yet in the aircraft). The related NPA, based on RMT.0621, would propose an amendment to CS-ETSO subpart A to allow ETSO authorisations for this intermediate integration step; and

(c) aircraft level when the IMA platform and all the aircraft functions hosted by it are installed and integrated on the airframe. This is covered by RMT.0622. The related NPA, proposing AMC 20-170, is planned to be published in 2015.

2.1.3 Today there is no Agency regulatory material at any of these three levels, while FAA covered level a) in 2002 (through TSO-C153) and level c) — in 2010 (through AC 20-170).

2.1.4 In the absence of published regulatory material, current IMA certification process:

(a) is based on Certification Review Items (CRIs) with interpretative materials, which are however Type Certificate (TC)/Supplemental Type Certificate (STC)-specific and, therefore, not publicly available to other interested parties;

(b) is dedicated to the IMA development and installation in a specific aircraft in the frame of a TC or a STC process;

(c) does not approve the platform independently of the aircraft, whereas IMA platforms are composed of modules which are designed to be reusable on several aircraft types and independent of the aircraft;

(d) does not allow a delivery of platforms and components accompanied by an ETSO authorisation, which penalises European manufacturers, in comparison with US ones.

2.1.5 The EUROCAE standard ED-124 (equivalent to the RTCA standard DO-297) on 'Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations', published in July 2007, provides guidelines on how to deal with the development and certification of IMA architectures but it is not yet enshrined in any regulatory material issued by the Agency, which is an additional reason to take regulatory action.

2.2. Objectives

The overall objectives of the EASA system are defined in Article 2 of the Basic Regulation. In addition to high and uniform safety across the 29 EU Member States, they include the following:

…..

(b) to facilitate the free movement of goods, persons and services;

(c) to promote cost-efficiency in the regulatory and certification processes;

…

(f) to provide a level playing field for all actors in the internal aviation market.

This proposal will specifically contribute to the achievement of the overall objectives by paving the way for cost-efficient and transparent certification process by offering to IMA manufacturers the possibility to obtain ETSO authorisations at platform/module level, independent from aircraft.

2.3. Summary of the Regulatory Impact Assessment (RIA)

The RIA in Chapter 4 considered the following options:

Table 1: Selected policy options

Option No	***Short title***	**Description**
0	'Do nothing'	Baseline option (no change in rules; issues remain as outlined in the above analysis).
1	No MPS	Follow the approach of FAA TSO C153 (no Minimum Performance Requirements (MPS) in ETSO-2C153) and therefore address performance during integration at aircraft level. No link between aircraft certification projects and ETSO authorisation.
2	Deferred ETSOA	Follow the approach of FAA TSO C153 (no Minimum Performance Requirements (MPS) in ETSO-2C153) and therefore address performance during integration at aircraft level. But also grant ETSO authorisation only after IMA equipment has been accepted in the context of a TC/STC project.
3	MPS	Publish ETSO-2C153 on 'IMA platform modules' (based on FAA C153 but introducemodifications, in particular MPS for various IMA Classes). No link between ETSOA and any (S)TC project. After the ETSO authorisation, the IMA components could be used during (S)TC projects without demonstrating the IMA performances (i.e. giving 'credit' to the ETSOA).
4	Intermediate integration	In addition to Option 3, provide, in the future, guidance in CS-ETSO Subpart A, for integration of two or more ETSO articles (e.g. IMA platform and at least one aircraft function, e.g. autopilot) before installation in the aircraft.

Option 4 is not analysed in detail in this NPA, since it is covered by RMT.0621.

Based on the Multi-Criteria Analysis (MCA):

- Option 0 ('do nothing') has a significantly negative total score, while being also slightly negative from the safety perspective.

- Option 1 (i.e. 'copy and paste' FAA TSO-C153, so not including minimum performance requirements) is the most negative in safety terms, while it has ving a slightly negative total score. Even if harmonised with FAA TSO, it is not even positive from the regulatory harmonisation perspective, since it is diverging from the principles of the EU 'better regulation'.

- Option 2 (i.e. apply totally the US approach and issue the ETSOA only after performance and safe integration have been demonstrated at aircraft level) is overall positive, but not from the proportionality and harmonisation (again reference to 'better regulation') perspective.

- Finally, Option 3 (publish ETSO-2C153 in Index 2 of CS-ETSO and include in it minimum performance specifications), has a very high total score and is significantly positive from the safety, environmental, social and economic point of view, while not being negative from the other perspectives. It is hence the preferred option.

2.4. Overview of the proposed amendments

2.4.1. Core section of proposed ETSO-2C153

The proposed ETSO-2C153 contains the minimum performance, data and environmental qualification requirements for various Integrated Modular Avionics (IMA) modules, which are parts designed to compose an IMA platform. Satisfying the requirements for one or more modules would allow the holder of the ETSO authorisation to use the ETSO-2C153 marking and to issue the declaration of conformity (i.e. EASA Form 1) for each produced unit.

Each IMA platform module will be considered as a Line Removable Module (LRM), whose replacement for repair is considered a maintenance, and not a design activity, according to rule 21.A.431 A in Part-21.

The proposed ETSO is composed of five initial pages (the core section) and four Appendices. It differs significantly from the corresponding FAA TSO-C153, since the latter does not contain minimum performance specifications. It would hence be inserted in Index 2 of CS-ETSO Subpart B.

The core section follows the format of all other ETSOs, comprising five paragraphs, respectively, on applicability, procedures, technical conditions, marking and reference documents.

2.4.2. Appendix 1 of proposed ETSO-2C153

Appendix 1 of the proposed ETSO-2C153 contains a descriptive overview of the Integrated Modular Avionics (Chapter 1), a list of applicable definitions (Chapter 2), the definitions of the classes of the intended functions in Chapter 3 and, finally, an illustrative example of an IMA platform using modules (Chapter 4).

In particular, seven possible function classes are identified in Chapter 3:

(a) Class RH (Rack housing);
(b) Class PR (Processing);
(c) Class GP (Graphical processing);
(d) Class DS (Data storage);
(e) Class IF (Interface);
(f) Class PS (Power Supply);
(g) Class DH (Display head).

2.4.3. Appendix 2 of proposed ETSO-2C153

Appendix 2 of the proposed ETSO-2C153 contains two introductory pages establishing the principle for the Minimum Performance Specification (MPS), as well as the naming convention and the verification procedures.

Furthermore, it contains eight Sub-appendices (from 2.1 to 2.8) describing in detail the MPS with which the applicant for an ETSO authorisation shall comply.

Sub-appendix 2.1 contains 'common' requirements applicable to all IMA modules. It is structured first defining the purpose and scope, and then listing the performance requirements and the verification, and test requirements and procedures.

Sub-appendix 2.2 on Class RH also starts with a paragraph on purpose and scope. Furthermore it contains paragraphs related to requirements and the last paragraph (i.e. 6) is on the verification procedure.

The same structure is used in the following Sub-appendices, respectively covering the remaining classes listed in 2.4.2 above.

2.4.4. Appendix 3 of the proposed ETSO-2C153

Appendix 3 of the proposed ETSO-2C153 contains requirements for the data to be submitted by the applicant, with reference to Eurocae ED-124, including the user guide and installation manual.

2.4.5. Appendix 4 of the proposed ETSO-2C153

Finally, Appendix 3 of the proposed ETSO-2C153 contains requirements for the environmental qualification of the various IMA modules, referring to ED-14/DO-160 as appropriate.

3. Proposed amendments

The text of the amendment is arranged to show deleted text, new or amended text as shown below:

(a) deleted text is marked with ~~strike through~~;

(b) new or amended text is highlighted in grey;

(c) an ellipsis (…) indicates that the remaining text is unchanged in front of or following the reflected amendment.

3.1. Draft Certification Specifications (Draft EASA Decision)

ETSO-2C153
Date: xx.08.14

European Technical Standard Order (ETSO)

SUBJECT: INTEGRATED MODULAR AVIONICS (IMA) PLATFORM AND MODULES

1 — Applicability

This ETSO gives the requirements that IMA modules which are designed to compose an Integrated Modular Avionics (IMA) platform and which are manufactured on or after the date of entry into force of this ETSO must meet in order to be identified with the applicable ETSO marking.

See **Appendix 1** for an introduction to Integrated Modular Avionics and applicable definitions.

EUROCAE ED-124 and RTCA DO-297 recognise incremental IMA system approval by introducing intermediate acceptance steps. ETSO-2C153 authorisation is an optional intermediate step to authorise IMA platform or IMA modules (independently of aircraft type approval). It encompasses environmental qualification, hardware qualification, software qualification and design approval of the intended function of resource sharing.

This ETSO refers to IMA platforms and modules, which are appliances composed of hardware, core software or any embedded software module contributing to the intended function of resources sharing.

Nevertheless, if the intended function of resource sharing is implemented:

- 'Hardware only' module is acceptable if no further software module is needed to perform resources sharing.
- Single LRU platform (as per EUROCAE ED-124/RTCA DO-297), where the platform is limited to one Line Removal Unit (LRU), is acceptable.

In the following content of this document, only the term 'IMA module' will be used.

The following is out of the scope of this ETSO-2C153:

- IMA platforms consisting of multiple LRUs or LRMs (distributed platform – ED-124/DO-297 example D2) that have to be addressed at system level.
- Stand-alone core software.
- Configuration data, which are part of IMA system integration and installation.
- IMA applications.
- Equipment used to generate radio frequency signals for intentional transmitters.

To apply for ETSO-2C153 authorisation, IMA module shall comply with common applicable requirements and shall implement at least one of the function classes:

- CLASS RH : Rack Housing
- CLASS PR : Processing
- CLASS GP : Graphical Processing
- CLASS DS : Data Storage
- CLASS IF : Interface
- CLASS PS : Power Supply
- CLASS DH : Display Head

See **Appendix 2** for common requirements and function classes' definitions.

An IMA module can be compliant with a combination of MPS classes. In this case, the IMA module will be marked with all the covered classes. However, as soon as a manufacturer voluntarily applies for ETSO-2C153 authorisation, all the classes for which the intended function is implemented shall be compliant.

Example: Single LRU platform will be authorised 'ETSO-2C153 CLASS PR + DS + IF' if the intended function of resource sharing is implemented on processing, data storage and interface.

For ETSO-2C153 CLASS DH authorisation, the IMA module shall be compliant with the requirements of ETSO-C113(*) 'Airborne Multipurpose Electronic Displays'. IMA module shall be marked with both ETSO-2C153 CLASS DH and ETSO-C113.

(*) Refer to most recent C113 revision applicable by CS-ETSO.

2 — Procedures
2.1. — General
Applicable procedures are detailed in CS-ETSO Subpart A.
Data to be submitted to EASA are defined in Part-21 Subpart O and in CS-ETSO Subpart A.

2.2 — Specific

Additional data which shall be submitted to EASA by IMA module manufacturer are specified in **Appendix 3**, including data required by ED-124 task 1 (see paragraph 3.2.2.1).

3 — Technical Conditions
3.1 — Basic
3.1.1 — Minimum Performance Standard
See **Appendix 2**.

3.1.2 — Environmental Standard
See CS-ETSO Subpart A paragraph 2.1 and **Appendix 4**.

3.1.3 — Computer Software
See CS-ETSO Subpart A paragraph 2.2.

3.1.4 — Electronic Hardware Qualification
See CS-ETSO Subpart A paragraph 2.3.

3.2 - Specific
3.2.1 — Failure Condition Classification
It is recognised that IMA module may be developed independently of a specific installation project and of future hosted aircraft functions, preventing the possibility to define the aircraft level failure condition which are out of the scope of this ETSO.

However, the module architecture and development will be driven by generic failure conditions. These can be considered as assumptions, which will drive the Development Assurance Level (DAL) allocation as per CS-ETSO Subpart A paragraph 2.4.

Assumed failure conditions and resulting DAL are characterisation items and shall be documented in the installation manual and Declaration of Design and Performance (DDP).

Qualitative and safety mechanisms requirements for each class are specified in the Minimum Performance Specification in Appendix 2.

3.2.2 — Specific Development and installation requirements
3.2.2.1 — Development process
EUROCAE ED-124/RTCA DO-297 'Integrated Modular Avionics (IMA) development guidance and certification considerations' contain guidance for IMA developers, application developers, integrators, certification applicants, and those involved in the approval and continuing airworthiness of IMA systems in civil certification projects.

In order to prepare the integration of the ETSO-2C153 IMA module, the development shall meet objectives of EUROCAE ED-124/RTCA DO-297 guidance related to task 1 (Table A-1 objectives).

Table A-1 objective 8 is:

- applicable to Single LRU platform.
- partially applicable to IMA module, for intrinsic validation and verification activities.

3.2.2.2 — Installation consideration

ETSO-2C153 IMA module is by definition an incomplete system.

Definition of activities to be performed to properly use the ETSO-2C153 IMA module shall be defined for the installer. Associated test procedures to check that the authorised IMA module is properly used shall also be documented in the installation manual in order to allow the integrator to perform task 3 and 4 of the EUROCAE ED-124/RTCA DO-297.

4 — Marking

4.1 — General

Marking is detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 — Specific

The part shall be permanently and legibly marked with the intended function class(es) as defined in paragraph 1 of this ETSO. This information shall be on the ETSO nameplate or in close proximity to the nameplate.

It is permitted to use electronic part marking to identify software or airborne electronic hardware components by embedding the identification within the hardware component itself (using software) rather than marking it on the equipment nameplate. If electronic marking is used, it must be readily accessible without the use of special tools or equipment.

Note: ETSO-2C153 marking does not cover IMA-hosted applications and IMA configuration which are software parts not covered by this ETSO.

5 — Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

APPENDIX 1

INTEGRATED MODULAR AVIONICS OVERVIEW, DEFINITION AND EXAMPLES

This Appendix provides:

- Chapter 1 : An overview of Integrated Modular Avionics (IMA)
- Chapter 2 : Applicable definitions
- Chapter 3 : Definition of Minimum Performance Specification (MPS) classes
- Chapter 4 : Examples of IMA platform using IMA modules

Chapter 1: Integrated Modular Avionics Overview

In this ETSO, Integrated Modular Avionics is defined according to EUROCAE ED-124 (equivalent to the RTCA DO-297):

Integrated Modular Avionics (IMA): is a shared set of flexible, reusable, and interoperable hardware and software resources that, when integrated, form a platform that provides services, designed and verified to meet a defined set of safety and performance requirements, to host applications performing aircraft functions.

IMA architecture integrates many aircraft functions on the same platform, provided by several hosted applications that historically have been contained in functionally and physically separated 'boxes' or LRUs.

IMA platforms are composed of modules which are designed to be reusable in order to reduce development cost and occasionally facilitate certification programmes. Some modules provide only mechanical, possibly cooling and electrical power supply functions. Others include core software and associated computing capabilities.

The IMA modules are usually both generic and configurable, and the same platform could therefore be used on different aircraft models.

Chapter 2: Applicable definitions

Legend

- *[ED-124]:* Definitions from EUROCAE ED-124 (equivalent to the RTCA DO-297).
- *[2C153]:* Definitions defined or refined in the frame of the ETSO.

Aircraft Function*[ED-124]*: The capability of the aircraft that may be provided by the hardware and the software of the systems on the aircraft.

Application*[ED-124]*: Software and/or application-specific hardware with a defined set of interfaces that, when integrated with the platform, performs a function.

Cabinet *[2C153]*: Result of the integration of hardware modules mounted within one rack.

Characterisation item *[2C153]*: Identified module characteristic towards which the IMA module developer needs to determine the module performance, with full verification and documentation in the user guide/installation manual as appropriate.

Component *[ED-124]*: A self-contained hardware, software part, database or combination thereof that is configuration-controlled. A component does not provide an aircraft function by itself.

Configuration data *[ED-124]*: See paragraph 3.7.1.

Core Software *[ED-124]*: The operating system and support software that manage resources to provide an environment in which applications can be executed. Core software is a necessary component of a platform and is typically comprised of one or more modules *(such as, for example, libraries, drivers, kernel, data-loading, boot, etc.)*.

Equivalence class *[ED-12C]*: The partition of the input domain of a programme such that a test of a representative value of the class is equivalent to a test of other values of the class.

IMA Platform *[ED-124]*: Module or group of modules, including core software, which manages resources in a manner sufficient to support at least one application. IMA hardware resources and core software are designed and managed in a way that provides computational, communication and interface capabilities for hosting at least one application. Platforms by themselves do not provide any aircraft functionality. The IMA platform may be accepted independently of hosted applications.

IMA System *[ED-124]*: Consists of (an) IMA platform(s) and a defined set of hosted applications.

LRM (Line Replaceable Module) *[2C153]*: IMA platform element, identified in aircraft configuration and replaceable by aircraft line maintenance to restore the aircraft into an operational ready condition. An IMA LRM is a stand-alone equipment which does not provide any aircraft function until IMA applications are integrated.

LRU (Line Replaceable Unit) *[2C153]*: Element supporting an aircraft function, identified in aircraft configuration and replaceable by aircraft line maintenance to restore the aircraft into an operational ready condition. An LRU is usually a stand-alone equipment such as a radio, Flight Management Computer or any functional equipment.

Module *[2C153]*: A component or collection of components that may be accepted by themselves or in the context of IMA. A module may be hardware, or a combination of hardware and software, which provides resources to the IMA-hosted applications. Application and module configuration data are not covered by this definition. Modules may be distributed across the aircraft or may be co-located.

Operating System*[ED-124]:*

1) The same as executive software.
2) The software kernel that services only the underlying hardware platform.
3) Software that directs the operations of a computer, resource allocation and data management, controlling and scheduling the execution of computer-hosted applications, managing memory, storage, input/output, and communication resources.

Rack *[2C153]*: A physical package able to contain at least two hardware modules, which may provide partial protection from environmental effects (shielding) and may enable installation on and removal of the mounted modules from the aircraft without physically altering other aircraft systems or equipment.

Support software *[2C153]*: Embedded software necessary as a complement to the operating system to provide general services such as contributing to the intended function of resources sharing, handling hardware, drivers, software loading, health monitoring, boot strap, etc.

Unit *[2C153]*: Set of physical components (hardware and or software) inside an equipment in charge of providing a resource.

Usage Domain *[2C153]*: The usage domain of an IMA module is defined as an exhaustive list of conditions (valid use cases) to be respected by the user(s) to ensure that the IMA module continues to meet the performance characteristics and requirements of the ETSO Minimum Performance Standard. Compliance with usage domain ensures that:

- the module is compliant with its functional, performance, safety and environmental requirements specified for all implemented intended functions.
- the module characteristics documented in the User Guide (as required by Appendix 2) are guaranteed by manufacturer.
- the module is compliant with the applicable airworthiness requirements (including continuing airworthiness aspects).

Chapter 3: Definition of Intended Function classes

To apply for ETSO-2C153 authorisation, IMA module shall comply with applicable common requirements and implement at least one Intended Function Class. As soon as a manufacturer applies for ETSO-2C153 authorisation, all the classes for which the Intended Function is implemented shall be compliant.

CLASS RH: Rack Housing

For ETSO-2C153 Class RH:

1.3.RH.1: IMA module is a physical package able to contain at least two hardware modules, that may provide protection from environmental effects (shielding, etc.) and enable installation and removal of those module(s) from the aircraft without physically altering other aircraft systems or equipment.

1.3.RH.2: IMA module may be a simple mechanical enclosure, or it may incorporate communication interfaces, backplanes for data and power supplies, active cooling or any combination of these features.

1.3.RH.3: IMA module does not offer the capability to host applications, unless combined with Class PR approval.

1.3.RH.4: IMA module may be configurable.

CLASS PR: Processing

For ETSO-2C153 Class PR:

1.3.PR.1: IMA module contains CPU component, memory component, interface devices and associated Core Software which constitute one or several Processing, Memory or Interface Unit(s).

1.3.PR.2: The intended function of such IMA module is to share Processing, Data and Information between at least two IMA applications, modules and/or components.

1.3.PR.3: IMA module offers the capability to host IMA applications.

1.3.PR.4: IMA module may be an association of hardware and Core Software.

- Hardware may (or may not) contain resident (not field-loadable) software to enable electronic part marking and/or future loading of Field-Loadable Software parts.

- Core Software may be resident or a Field-Loadable Software Part.

1.3.PR.5: IMA module may be configurable.

CLASS GP: Graphical Processing

For ETSO-2C153 Class GP:

1.3.GP.1: IMA module contains graphical engine component and optional video engine component, memories, interfaces and potentially associated Core Software which constitute one or several Graphical Unit(s).

1.3.GP.2: The intended function of such IMA module is to share graphics and optional video signal processing between at least two IMA applications, modules and/or components.

1.3.GP.3: IMA module does not offer the capability to host IMA applications, unless combined with Class PR approval.

1.3.GP.4: IMA module may be an association of hardware and Core Software.

- Hardware may (or may not) contain resident (not field-loadable) software to enable electronic part marking and/or future loading of Field-Loadable Software parts.
- Core Software may be resident or a Field-Loadable Software Part

1.3.GP.5: IMA module may be configurable.

CLASS DS: Data Storage

For ETSO-2C153 Class DS:

1.3.DS.1: IMA module contains memory, interface component and potentially associated Core Software which constitute one or several Data Storage Unit(s).

1.3.DS.2: The intended function of such IMA module is to share stored data (e.g. databases, files, etc.) between several applications, modules and/or components.

1.3.DS.3: IMA module does not offer the capability to host applications, unless combined with Class PR approval.

1.3.DS.4: IMA module may be an association of hardware and a Core Software.

- Hardware may (or may not) contain resident (not field-loadable) software to enable electronic part marking and/or future loading of Field-Loadable Software parts.
- Core Software may be resident or a Field-Loadable Software Part.

1.3.DS.5: IMA module may be configurable.

CLASS IF: Interface

For ETSO-2C153 Class IF:

1.3.IF.1: IMA module contains input/output component(s) and potentially associated Core Software which constitute one or several Interface Unit(s). These interfaces can be discrete, analogue, serial interface, digital bus, etc.

1.3.IF.2: The intended function of such IMA module is to share information between several IMA applications, modules and/or components.

1.3.IF.3: IMA module does not offer the capability to host applications, unless combined with Class PR approval.

1.3.IF.4: IMA module may be an association of hardware and a Core Software.

- Hardware may (or may not) contain resident (not field-loadable) software to enable electronic part marking and/or future loading of Field-Loadable Software parts.
- Core Software may be resident or a Field-Loadable Software Part.

1.3.IF.5: IMA module may be configurable.

CLASS PS: Power Supply

For ETSO-2C153 Class PS:

1.3.PS.1: IMA module contains a set of components (hardware and or software) which constitute one or several Power Supply Unit(s) in charge of managing power supply.

1.3.PS.2: The intended function of such IMA module installed into a rack (Class RH module) is to provide power supply from airborne electrical network to one or more hardware modules embedded into the same rack.

1.3.PS.3: IMA module does not offer the capability to host applications, unless combined with Class PR approval.

1.3.PS.4: IMA module may be configurable.

1.3.PS.5: IMA module may be an association of hardware and a Core Software.

- Hardware may (or may not) contain resident (not field-loadable) software to enable electronic part marking and/or future loading of Field-Loadable Software parts.
- Core Software may be resident or a Field-Loadable Software Part.

CLASS DH: Display Head

For ETSO-2C153 Class DH:

1.3.DH.1: IMA module contains a set of components (hardware and/or software) in charge of managing displayed area which constitute one or several Display Unit(s).

1.3.DH.2: The intended function of such IMA module is to offer the capability to depict graphical information received from IMA Application(s), component(s) and/or module(s) on one Display Area.

1.3.DH.3: IMA module does not offer the capability to host applications, unless combined with Class PR approval.

1.3.DH.4: IMA module may be an association of hardware and a Core Software.

- Hardware may (or may not) contain resident (not field-loadable) software to enable electronic part marking and/or future loading of Field-Loadable Software parts.
- Core Software may be resident or a Field-Loadable Software Part

1.3.DH.5: IMA module may be configurable.

Chapter 4: Example of IMA platform using IMA modules

EUROCAE ED-124/RTCA DO-297 contains some examples relating to the definition of IMA module and platform, which These can be completed by the example relating to Chapter 3 definitions.

Example 1: Single LRU platform (as per EUROCAE ED-124/RTCA DO-297).

This example illustrates the sharing of computational and Input/Output (I/O) resources within a single Line Replaceable Unit (LRU). Key such IMA system characteristics include:

- Hosting of multiple applications (not part of the IMA platform).
- Platform configuration data and data loading.
- Defined API between the IMA platform and hosted applications.

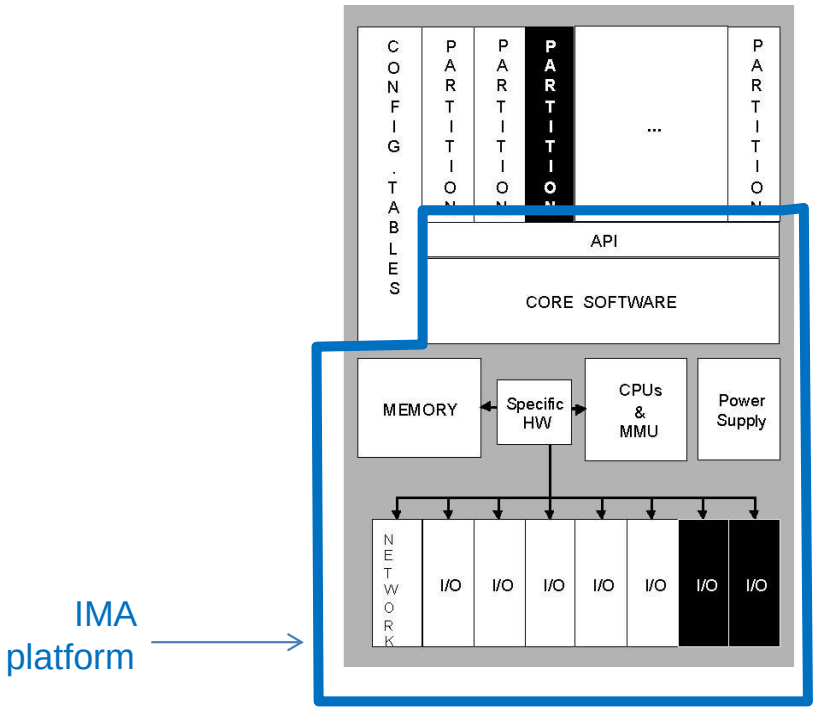

Figure 1 Single LRU platform (as per EUROCAE ED-124/RTCA DO-297)

At one level, this example illustrates a single platform providing core computational resources. At another level, it illustrates a module to be used within a larger IMA platform.

If sharing of processing, memory, and I/O resources is implemented within the LRU, such single LRU platform will be **eligible to CLASS PR, DS and IF**.

Example 2: Single LRU A664 switch equipment.
This example illustrates the sharing of ARINC Specification 664 I/O resources within a single Line Replaceable Unit (LRU).

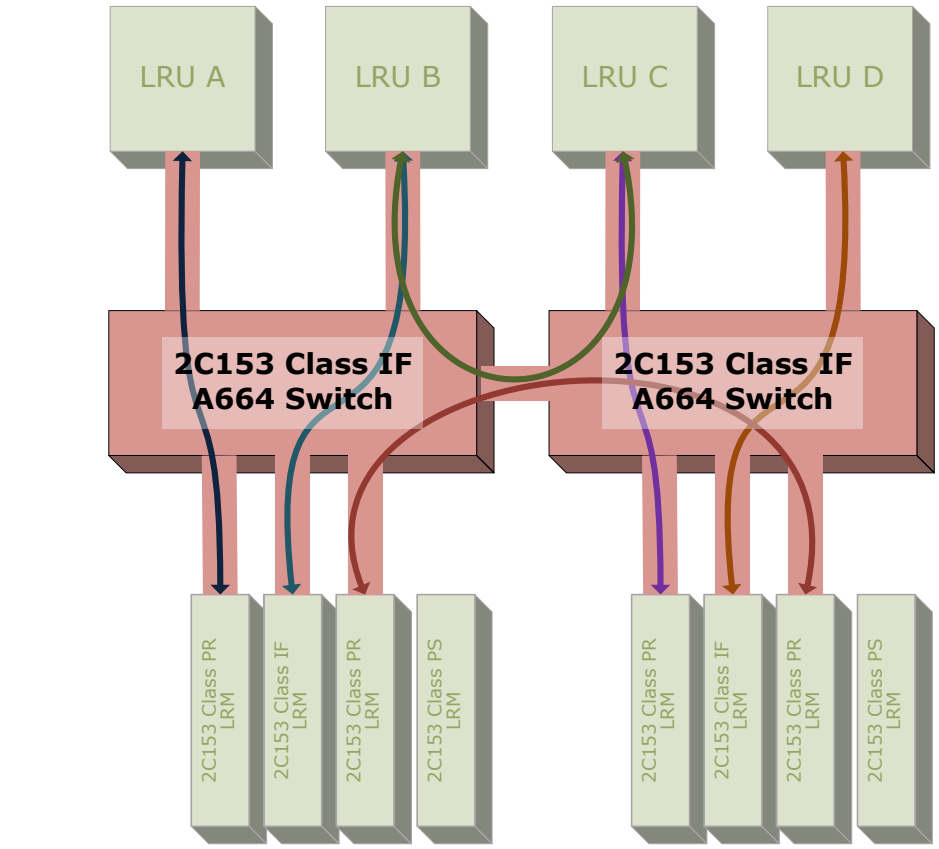

Figure 2: Example a an architecture based on two ETSO-2C153 modules IF modules implementing each an ARINC 664 switch.

In this architecture, the two ETSO-2C153 class IF modules are switching A664 frames, providing each of the subscriber a shared access to the network. Network subscribers can be other ETSO-2C153 modules as the lower row of modules shows, or non-IMA equipment (top row) such as displays, radio transceivers.

If sharing of ARINC Specification 664 I/O resources is implemented within the LRU, such single LRU platform shall be eligible to **CLASS IF**.

Example 3: IMA modules installed in a Rack Module (Line Replaceable Module).

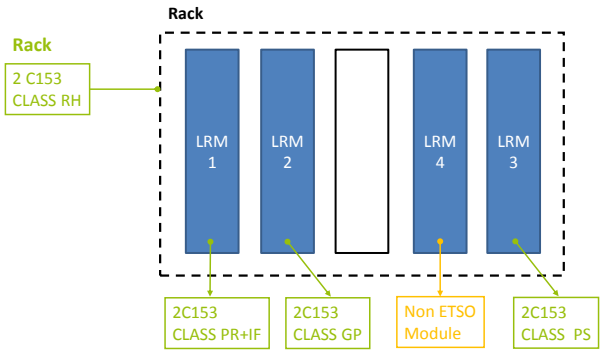

Figure 2 IMA modules installed in a Rack Module

This example illustrates the sharing of resources within several single Line Replaceable Modules (LRM) installed in a Rack:

- Rack: is an IMA module and will be eligible to **CLASS RH**;
- LRM 1: provides shared Processing and Input/Output and shall be eligible to **CLASS PR+IF**;
- LRM2: provides shared Graphical Processing and shall be eligible to **CLASS GP**;
- LRM3: provides shared Power Supply to LRM embedded into the same rack and shall be eligible to **CLASS PS**;
- LRM 4: does not provide shared resource. This module shall be considered as a non-ETSO-2C153 module.

All these modules are considered as Parts.

APPENDIX 2

INTEGRATED MODULAR AVIONIC MODULE MINIMUM PERFORMANCE SPECIFICATION (MPS)

This Appendix provides Specific Minimum Performance Specification for IMA modules.

Principle

An IMA module is composed of hardware components or hardware and software components performing the intended function(s) whose minimum performance requirements are specified in this Appendix 2.

This Minimum Performance Specification (MPS) is structured in a common requirements section and a set of classes specifying IMA module intended function(s):

- COMMON: Minimum Performance Specification applicable whatever IMA module and whatever the implemented intended function class(es).
- CLASS RH: Rack Housing intended function.
- CLASS PR: Processing intended function.
- CLASS GP: Graphical Processing intended function.
- CLASS DS: Data Storage intended function.
- CLASS IF: Interface intended function.
- CLASS PS: Power Supply intended function.
- CLASS DH: Display Head intended function.

To apply for ETSO-2C153 authorisation, IMA module shall comply with common Minimum Performance Standard and implement at least one Intended Function Class as defined in this Appendix 2.

When applying for ETSO-2C153 authorisation, the applicant shall include in the certification basis all classes for which the intended function is implemented in the IMA module/platform.

Convention naming

This document contains '**shall**', '**may**' and '**will**' statements with the following meanings:

- The use of the word '**shall**' indicates a mandated criterion; i.e. compliance with the criterion is mandatory and no alternative may be applied;
- The use of the word '**may**' indicates that though the criterion is regarded as the preferred option, alternative criteria may be applied. In such cases, alternatives should be identified in appropriate approval plans and agreement sought from the approval authority; and
- The use of the word '**will**' describes an example.

Verification Procedures

For verification procedures, following definitions and symbols are used in this Appendix:

Analysis (A)

Analysis is the method of verification which consists in comparing design with known scientific and technical principles, technical data, or procedures and practices to validate that the proposed design will meet the specified functional or performance requirements.

Demonstration (D)

Demonstration is the method of verification where qualitative versus quantitative validation of a requirement is made during a dynamic test of the system/equipment. In general, software functional requirements are validated by demonstration since the functionality must be observed through some secondary media.

Inspection (I)

Inspection is the method of verification to determine compliance with requirements and consists primarily of visual observations or mechanical measurements of the system/equipment, physical location, or technical examination of engineering support documentation.

Test (T)

Test is the method of verification that will exercise equipment functions and measure system/equipment performance under specific configuration and load conditions and after the controlled application of known stimuli. Quantitative values are measured, compared against previous predicated success criteria and then evaluated to determine the degree of compliance.

X/Y

Either test method X or test method Y may be used to verify the requirement (i.e., D/A can be verified by Demonstration or Analysis).

X+Y

Both test methods must be used to verify the requirement (i.e., D+A means the requirement must be verified by Demonstration and Analysis).

APPENDIX 2.1

INTEGRATED MODULAR AVIONIC MODULE
MINIMUM PERFORMANCE SPECIFICATION (MPS)

COMMON: Applicable to all the IMA modules

1. Purpose and scope

This section contains a set of Minimum Performance Standards (MPS) applicable to any IMA module and to any implemented intended function class(s).

In the following, the term '*concurrent item*' designates the item using the shared resource of the IMA module. Depending on the module class, it means '*Processing element*' for PR class, '*thread*' for GP, IF and DH class, '*data storage element*' for DS class, and '*power rail*' for PS class.

2. Requirement

2.1 Functional Requirements common to all classes:

CO.a) The IMA shall implement at least one Function Class.

The following requirements of this paragraph are applicable to all classes with some exception as described below:

CO.b) Except for the Housing function (F1) of the class RH (see Appendix 2.2 - paragraph 2.1), the IMA module shall provide at least the following control features to react to detected failures:

a. disable

b. reset

The IMA module may also implement the capability to reload.

CO.c) Except for the Housing function (F1) of the class RH (see Appendix 2.2 - paragraph 2.1), each IMA module shall provide health management and reporting capability.

CO.d) If existent, the health management and reporting function shall detect, isolate, contain and report faults in the shared resources and other resources that could adversely affect applications using the module resources or that could adversely affect the resources themselves.

CO.e) Except for class RH, the robust partitioning (as per EUROCAE ED-124/RTCA DO-297) between 'concurrent items' sharing the resource shall be ensured by the IMA module.

CO.f) Except for class RH, robust partitioning shall not rely on any required behavior of any aircraft function or hosted application (as per EUROCAE ED-124/RTCA DO-297 Section 3.5c).

CO.g) Except for class RH, any breach in robust partitioning shall be detected by the IMA module. An appropiate process and means should be implemented to ensure that such failures which result or may result in an unsafe condition are reported.

CO.h) Except for class RH, the IMA module shall implement a fault containment mechanism to prevent fault propagation between 'concurrent items' using the shared resource elements and to other IMA modules.

CO.i) Except for class RH, resource sharing and access to the resource by 'concurrent items' may be configurable.

CO.j) Except for the Housing function (F1) of the class RH (see Appendix 2.2 - paragraph2.1), the interface between the 'concurrent items' and the shared resource shall conform to characteristics as described by a standard (ARINC specifications 653, 664, 600, for example).

2.2 Characterisation Requirements:

CO.k) Each item of the characterisation shall be documented in the User Guide / Installation Manual as appropriate.

CO.l) The IMA module specification shall be characterised based on items in the table below (Figure 1) and on the characterisation requirements identifying additional characterisation items specific to each functional class (defined in Appendix 2 - class RH, or PR, GP, DS, IF, PS, DH).

CO.m) Quantifiable characterised item shall be quantified with minimum, typical (when relevant) and maximum values.

CO.n) The characterisation of IMA module shall be correct and complete. Completeness is achieved when all features related to potentially shared functions of the IMA module have been characterised.

CO.o) The characterisation shall identify all valid use cases of the IMA module.

CO.p) The characterisation shall provide all constraints (including user guide, limitations, usage domain and activities) to be respected by the users.

CO.q) The characterisation shall provide the list of types of shared resource elements, the associated attributes, their configurability and their timing and sizing performances.

CO.r) If IMA module contains a core software, the characterisation shall include at least the following characteristics of the core software:

a. Identification of the core software component(s).

b. Part of IMA module functionality, performance and safety requirements supported by the core software.

c. Interfaces and associated data coupling/control coupling information.

d. Integration and loading procedure(s).

e. Development assurance level(s).

CO.s) When the IMA is offering the capability to host software, the characterisation shall provide any data needed to evaluate Worst Case Execution Time (WCET) of each concurrent item sharing the IMA module resource.

CO.t) The performances of each shared resource management mechanism including monitoring shall be characterised, in particular the range, timing aspects, transients, etc.

CO.u) For at least the following failure modes, the failure rate shall be provided:

a. Loss of the IMA module.

b. Erroneous behavior of the IMA module.

c. Loss of the shared resource element.

d. Erroneous behavior of shared resource element.

CO.v) The characterisation shall include the monitoring coverage rate (PBIT, CBIT, etc) for all failure modes of the IMA module (including shared and unshared resources, sharing mechanisms and robust partitioning mechanisms).

CO.w) The characterisation shall address the safety aspects of bad sequencing, delay, corruption and impersonation.

CO.x) The following health monitoring items shall be included in the characterisation:

a. interface rules, constraints (including limitations) to be respected by the users,

b. list of Health Monitoring services,

c. list of monitored components, monitored services, monitored interfaces,

d. response to each type of fault,

e. fault reporting attributes (reporting refers to internal logging, indication to applications using the shared resources, indication outside of the module),

f. the configuration attributes, if any.

CO.y) If the IMA module is configurable, the characterisation shall include, in addition, the following items:

a. The authorised configuration parameters (including combined parameters) in the usage domain.

b. The configuration activities to be conducted (including configuration procedures, means and tools) by the user during application development (EUROCAE ED-124 – Task 2) and IMA system (EUROCAE ED-124 – Task 3 and 4) integration.

CO.z) If some tools are required for installation, these tools shall be characterised as follows:

a. Identification,

b. The user's manuals of tools,

c. The activities related to those tools to be conducted during application development (EUROCAE ED-124 – Task 2) and IMA system (EUROCAE ED-124 – Task 3 and 4) integration.

d. The proposed associated qualification credits that could be granted to the user of the tools.

e. The Category of the tool and the Development Assurance Level of the tool (if any).

CO.aa) The compatibility & mixability information between hardware, software, tools and usage domain shall be part of the characterisation. This shall address at least the following:

a. How the authorised mixed combinations are verified.

b. The compatibility assessment process with authorised mixed combinations of interfacing module (external mixability).

c. Any preventative measures (design or procedures) to be developed by the user to prevent incorrect module combinations or software loads.

d. Information to be provided to maintenance personnel.

CO.bb) The control features (disable, reset, reload, etc.) of the IMA module to react to detected failures shall be characterised.

Characterisation Category	Characterisation item
General Information	
	Power Dissipation.
	Thermal characteristics.
	Temperature control (e.g. cooling) characteristics.
	Size and Weight.
	Input and Output (I/O) Connectors (including pin-out).
	Mating Connectors.
	Top-level drawings and Mechanical Interfaces.
	Mounting Mechanism and scheme.
	Clearance characteristics.
	Air Flow characteristics.
	Inter-Element Interfaces.
	Inter-Element Connections.
	Grounding and Shielding Provisions.
	Separation and/or Isolation Provisions.
	Module Installation and Extraction Means.
	Backplane Interface.
Interfaces	**Analog Input Specifications For Each Analog Input**
	Type of Analog (e.g. differential, isolated, etc.)
	Range.
	Accuracy.
	Resolution.
	Null and Offset.
	Filtering.
	Input Impedance.
	Analog-to-Digital Conversion Speed.
	Digital-to-Analog Conversion Speed.
	Steady State Voltage Rating.
	Transient Voltage Rating.
	Circuit Protection Techniques.
	Multiplexing.
	Latency Time.
	Bandwidth.
	Analog Output Specifications For Each Analog Output
	Type of Analog (e.g. differential, isolated,etc.)

Characterisation Category	Characterisation item
	Range.
	Accuracy.
	Null.
	Linearity.
	Current Capacity.
	Output Impedance.
	Analog/Digital Conversion Speed.
	Steady State Voltage Rating.
	Transient Voltage Rating.
	Circuit Protection Techniques.
	Multiplexing.
	Latency Time.
	Bandwidth.
	Discrete Input Specifications For Each Discrete Input
	Trip Point.
	Hysteresis.
	Filtering.
	Input Impedance.
	Logic Sense.
	Maximum Logic-High Level.
	Maximum Logic-Low Level.
	Minimum Logic-High Level.
	Minimum Logic-Low Level.
	Steady State Voltage Rating.
	Transient Voltage Rating.
	Circuit Protection Techniques.
	Multiplexing.
	Discrete Output Specifications For Each Discrete Output
	Voltage Levels.
	Current Source Capacity.
	Current Sink Capacity.
	Output Impedance.
	Circuit Protection Techniques.
	Multiplexing.
	Digital Communications For Each Input and Output
	Data Rates.
	Integrity Checks.

Characterisation Category	**Characterisation item**
	Signal Levels.
	Current Sink and Source.
	Input Impedance.
	Output Impedance.
	Signal Rise and Fall Times.
	Filtering.
	Stub Length Limits.
	Input and Output Capacitance.
	Isolation.
	Maximum Bit Error Rates.
	Circuit Protection Techniques.
	Resets.
	Monitors.
	Multiplexing.
Processing and Memory (inc. Graphical)	
	Included Software Services (Core Software) and associated performances: Data loading, Health Management, Operating System.
	Processing Unit (CPU, GPU, etc.) Component(s) Bus(es) and Core Clock Frequencies.
	Memory Size(s), Type(s) and Timing(s)
	Local data bus(es) Type(s) and Timings
	Start-up and Reset mechanisms and timings
Display and Rendering	
	Refer to SAE AS8034 'Minimum Performance Standard for Airborne Multipurpose Electronic Displays' (revision as defined in the applicable release of ETSO-C113)
Power Supply	
	Regulation.
	Input Voltage & Current range.
	Maximum Start-up (In-rush) Current Rating.
	Hold-up Capacity.
	Restart.
	Transient Immunity.
	Short Circuit Management.
	Power Resets and Recovery.
	Circuit Protection Techniques.
	Slew rate at start-up.

Figure 3: IMA module Characterisation Categories

3. Verification requirements

CO.cc) Each requirement shall be verified.

CO.dd) Each characterisation item of IMA modules and functions, their associated attributes, their configurability and their performances shall be completely verified. Test shall be preferred to other verification methods whenever technically possible.

CO.ee) All use cases identified as valid of the IMA module shall be verified.

CO.ff) A set of verification procedures to demonstrate compliance of the IMA module with the applicable MPS shall be developed and proposed as part of the certification data package.

CO.gg) There is a distinction between demonstrating the capability of sharing and demonstrating the performance of that sharing function. When demonstrating the performance of the IMA module, a subset of the characterisation items that allows guaranteeing the behavior of the complete IMA module over environmental testing has to be defined and submitted together with the Qualification Test Plan. Note that this functional subset should be detailed enough to sufficiently cover the complete IMA module performance

..

4. Test Software representativeness

When embedded software is needed to test the IMA module:

IMA module is certified without the functional software (IMA applications) installed and operating.

CO.hh) Engineering analysis from the design holder shall determine that the test software (not the target functional software) is representative of usage domain envelop or valid equivalence classes related to the verification procedures.

5. Verification procedures

The following table gives verification method for each requirement.

Requirement identifier	Verification method	Test under normal conditions	Test Functional Subset(1) under environmental conditions	Comment
CO.a)	I			
CO.b)	T	Y		
CO.c)	A			
CO.d)	T	Y	Y	
CO.e)	T	Y	Y	
CO.f)	A			
CO.g)	T			
CO.h)	T(A*)	Y		
CO.i)	A			
CO.j)	T(A*)	Y		
CO.k)	I			
CO.l)	A			
CO.m)	A			
CO.n)	A			
CO.o)	I			
CO.p)	A			
CO.q)	I			
CO.r)	I			
CO.s)	A			
CO.t)	A			
CO.u)	I+A			
CO.v)	I+A			
CO.w)	I+A			
CO.x)	A			
CO.y)	A			
CO.z)	A			
CO.aa)	A			
CO.bb)	A			
CO.cc)	I+A			
CO.dd)	T(A*)	Y	Y	
CO.ee)	T(A*)	Y	Y	
CO.ff)	A			
CO.gg)	A			
CO.hh)	A			

Table 2 : Verification Acceptance Criteria

(A*): means that verification by Analysis method is possible for item that cannot be tested.

Note (1): applicable for a Functional subset → cf. CO.gg).

APPENDIX 2.2

INTEGRATED MODULAR AVIONIC PLATFORM AND MODULE MINIMUM PERFORMANCE SPECIFICATION (MPS)

CLASS RH : Rack Housing

1 Purpose and scope

1.1 Introduction

This document contains Minimum Performance Standards (MPS) for CLASS RH Intended Function: Rack Housing.

These standards specify module characteristics that should be useful to designers, manufacturers, installers and users of the IMA module.

1.2 Definitions

For ETSO-2C153 CLASS RH, IMA module is a physical package able to contain at least two hardware modules, which may provide partial protection from environmental effects (shielding, etc.) and enable installation and removal of those module(s) from the aircraft without physically altering other aircraft systems or equipment.

These IMA modules may be simple mechanical enclosures, or they may incorporate passive communication interfaces, passive interconnection for data and power, active or passive cooling unit or any combination of these features.

Following definitions are used:

- 'Mounted' refers to another hardware module, installed and fixed inside the IMA Rack Module, after a human operation.
- Slot: the physical space dedicated to one hardware module inside the Rack Module, which allows mounting the former module.

These definitions are independent of the design choices made by the IMA module manufacturer.

Note:

- IMA module compliant to ETSO-2C153 CLASS RH MPS is only relevant in case of IMA platform architecture using a Cabinet.
- Hardware modules mounted inside the Rack Housing will be themselves IMA modules (compliant with ETSO-2C153 MPS other classes than RH) or non-IMA modules (i.e. non-IMA application specific hardware).

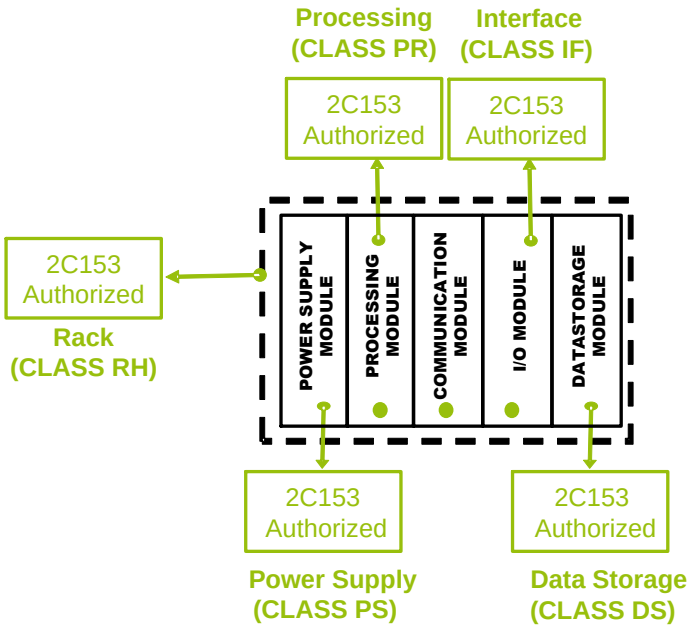

Figure 4 Illustration of IMA platform architecture based on Cabinet

1.3 Intended function

For ETSO-2C153 CLASS RH, the intended function is to provide the capability to share some housing services supplied by one mechanical unit.

This intended function can be divided into 4 subfunctions:

- F1 : Housing (mandatory);
- F2 : Shielding (optional);
- F3 : Interconnection (optional);
- F4 : Temperature control (optional).

The following figure provides an overview of the previously mentioned Rack Housing Module intended functions and definitions.

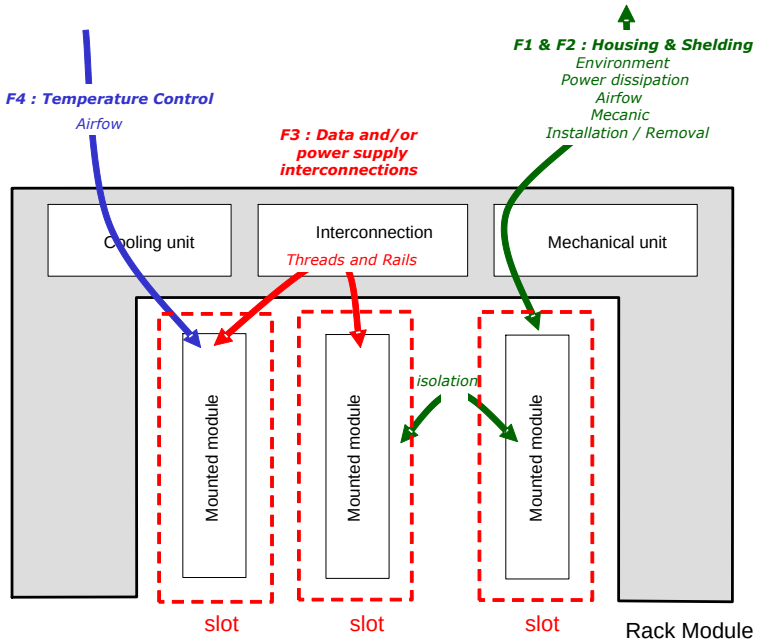

Figure 5: IMA module overview for ETSO-2C153 CLASS RH

2 Requirements for Housing (F1)

For ETSO-2C153 CLASS RH, IMA module provides shared resources for housing needs of hardware modules. This subfunction merges:

- The capacity to host at least two hardware modules inside at least two slots.
- The capacity to mount and dismount a hardware module in its slot directly in the aircraft thanks to a human (potentially tooled) intervention.

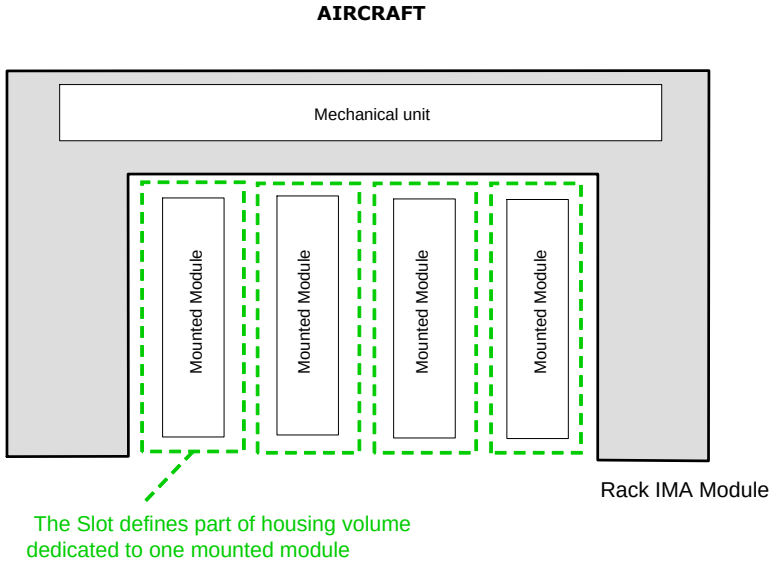

Figure 6: CLASS RH Housing function overview

2.1 Functional requirements for ETSO-2C153 CLASS RH (F1): Housing

RH.a) The Rack Housing shall permit to install and attach at least two hardware modules, one of which (at least) being an IMA module, inside its mechanical structure.

RH.b) The Rack Housing shall ensure the mechanical isolation between the different mounted hardware modules.

RH.c) For each type of slot, a means to avoid installation of unintended hardware module or inappropriate installation shall be implemented (e.g. mechanical key).

RH.d) If compliance with MPS requires any additional mechanical component, in the case this component is separable, it shall be marked with its Part Number.

RH.e) The external mechanical interface(s) of the Rack Housing module should conform to characteristics as described by a standard (e.g. ARINC600). Some characteristics of the slots may be configurable.

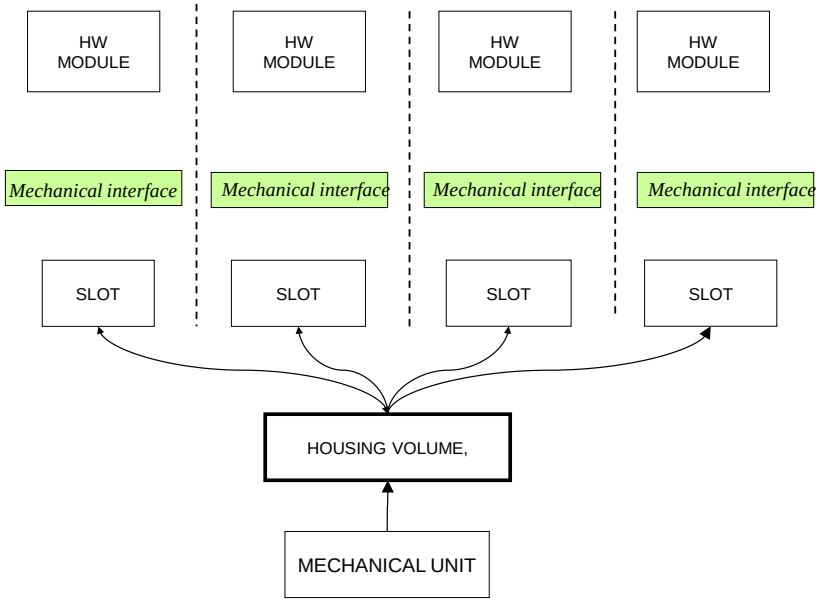

Figure 7: CLASS RH Housing elements relationship

2.2 Characterisation requirements for ETSO-2C153 CLASS RH (F1): Housing

RH.f) The following housing performances or housing characteristics of the Rack module shall be provided as part of the characterisation:

1. Size, mass and centre of gravity;
2. Clearance scheme;
3. Top-level drawings and mechanical interfaces;
4. Module mounting scheme;
5. Installation and extraction mechanisms;
6. Temperature control (e.g. airflow, cooling, etc) performances if function is implemented;
7. Lists of slots and associated performances (physical scheme, temperature profile, connector, etc.).

Note: These characterisation requirements are additional to those applicable in COMMON - Appendix 2.1).

RH.g) The characterisation shall include the description of the mounted hardware module installation and extraction means and methods.

RH.h) The characterisation shall provide the list of type of slots, the associated attributes, their configurability (if any) and their sizing dimensions (drawings).

This characterisation shall include:

1. The list of authorised or predefined hardware modules (if any).
2. The list of minimum requirements that a hardware module shall comply with for its capacity to be inserted into the rack.
3. Slot mounting scheme (mechanical profile/drawings) and characteristics (torque, max number of insertions, etc.)
4. Power dissipation and airflow profile.

RH.i) The characterisation, including the usage domain, shall be sufficiently accurate to permit specification and validation of the expected performance of the mounted hardware module.

RH.j) The characterisation shall include any data needed to evaluate mass and centre of gravity for a populated and partly populated rack.

RH.k) The characterisation shall include the installation instructions of the additional mechanical component necessary to be compliant with MPS.

3 Requirements for Shielding (F2)

F2 is an optional subfunction of ETSO-2C153 CLASS RH.

In this case, IMA module provides shared resources in terms of protection of mounted hardware modules. This subfunction merges:

- A level of protection of the mounted hardware modules from aircraft environment (including but not only, HIRF and Lighting effects).
- A level of environmental isolation (shielding) between mounted hardware modules inside the rack.

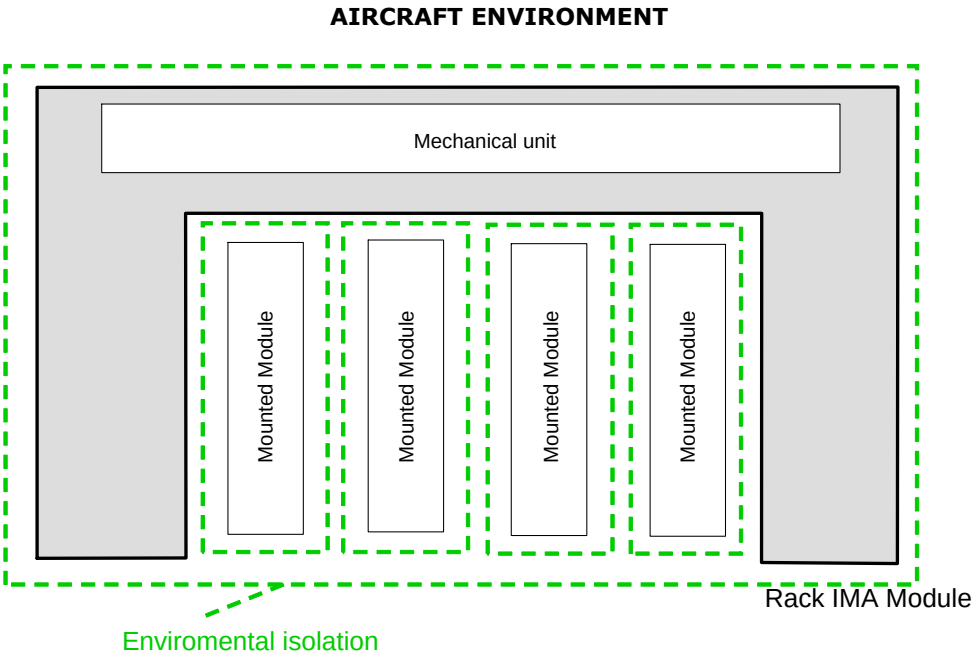

Figure 8: CLASS RH Shielding function overview

3.1 Functional requirements for ETSO-2C153 CLASS RH (F2): Shielding

RH.l) A level of environmental protection (shielding) for each mounted hardware modules shall be ensured by the Rack Housing IMA Module. This protection shall take into account level and severity retained for EUROCAE ED-14/RTCA DO-160 qualification of the IMA module (see Appendix 4) (outside the rack) and the interactions between the mounted hardware modules themselves (inside the rack).

RH.m) Protection performances of the IMA module (Rack module) shall be valued and guaranteed for each slot and for each EUROCAE ED-14/RTCA DO-160 section.

RH.n) Some characteristics of the slots may be configurable.

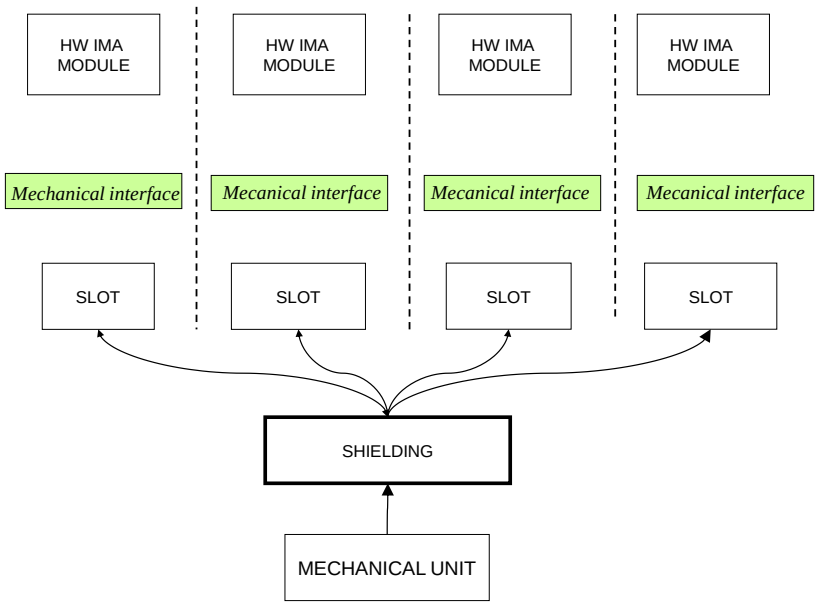

Figure 9: CLASS RH shielding elements relationship

3.2 Characterisation requirements for ETSO-2C153 CLASS RH (F2): Shielding

RH.o) The level of environmental protection (shielding) of each slot provided in Appendix 2.2 paragraph 1.1 shall be characterised, bounded and documented in the installation manual.

RH.p) The characterisation shall include the failure modes and rates of protection features (such as lighting protections, etc.) to support IMA system Safety Analysis (as per EUROCAE ED-124) at installation.

RH.q) The characterisation shall include the list of type of slots and the associated characteristics in terms of environmental protection (shielding).

This shall include:

1. The list of authorised or predefined hardware modules (if any).
2. The list of minimum requirements that a hardware module shall comply with for its capacity to be inserted into the rack.
3. Slot Mounting Scheme (mechanical profile/isolation/drawings).
4. Level of isolation and level of shielding per slot according to EUROCAE ED-14/RTCA DO-160 section.

RH.r) The characterisation shall include the list of environmental tests that can be granted to a hardware module (see Appendix 4 - EQT) mounted into the rack.

RH.s) The characterisation shall include all the possible configurations allowed for the configurable slot.

RH.t) If the RH.l) shielding objective is met thanks to any additional mechanical element, its installation shall be specified in the installation manual.

4 Requirements for Interconnection (F3)

F3 is an optional subfunction of ETSO-2C153 CLASS RH.

In this case, an IMA module provides the capacity to interconnect hardware modules together inside the Rack Module. This interconnection allows exchanging data or power supply.

Note:

- The data and power supply interconnection capacity is only composed of passive components.
- To ensure power supply exchange between mounted hardware modules at least one ETSO-2C153 CLASS PS module needs to be mounted into a slot to deliver electrical energy to other hardware modules.

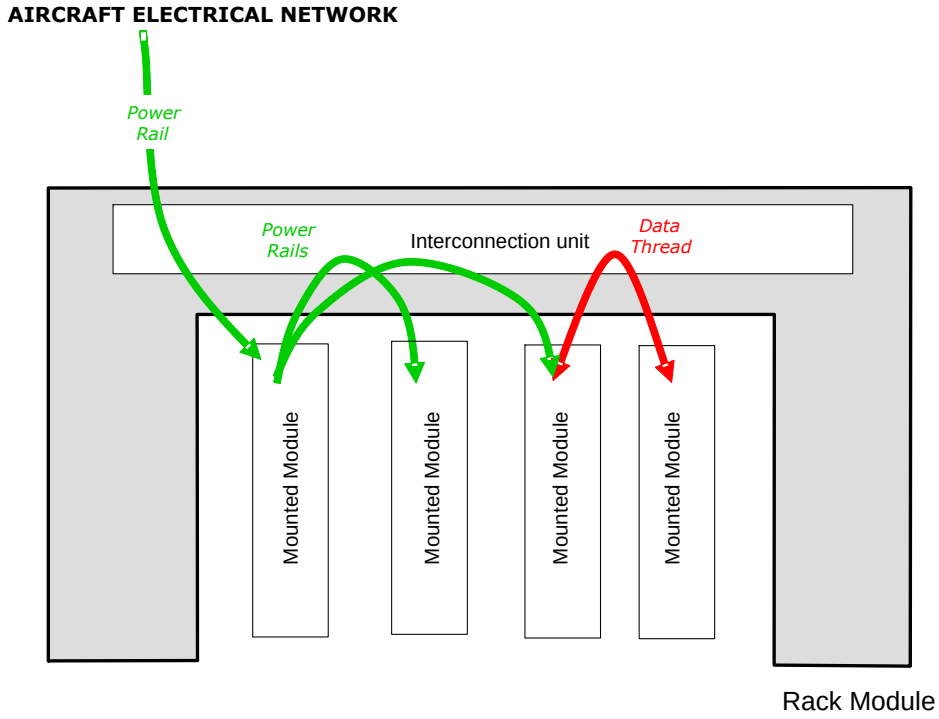

Figure 10: CLASS RH Interconnection function overview

4.1 Functional requirements for ETSO-2C153 CLASS RH (F3): Interconnection

RH.u) The IMA module shall provide the capacity to interconnect mounted hardware modules thanks to data or power supply buses available through an electrical interface(s) supplied by one or several interconnection unit(s). These buses shall be dedicated to:

a. data exchanges;

b. power supply exchanges.

RH.v) If the IMA module provides more than one bus, the isolation between buses used by mounted hardware modules shall be ensured by the IMA module. This isolation shall be substantiated by a Partitioning Analysis and Environmental Qualification Testing.

RH.w) The interface(s) of the IMA module should conform to characteristics as described by a standard (e.g. ARINC 600 or ARINC 664).

RH.x) The data and power supply buses shall not degrade the transmitted signals below the characterised performance.

RH.y) For ETSO-2C153 CLASS RH, the IMA module shall implement a fault containment concerning interconnection unit to prevent fault propagation between signals (data, discrete, power supply buses, etc.).

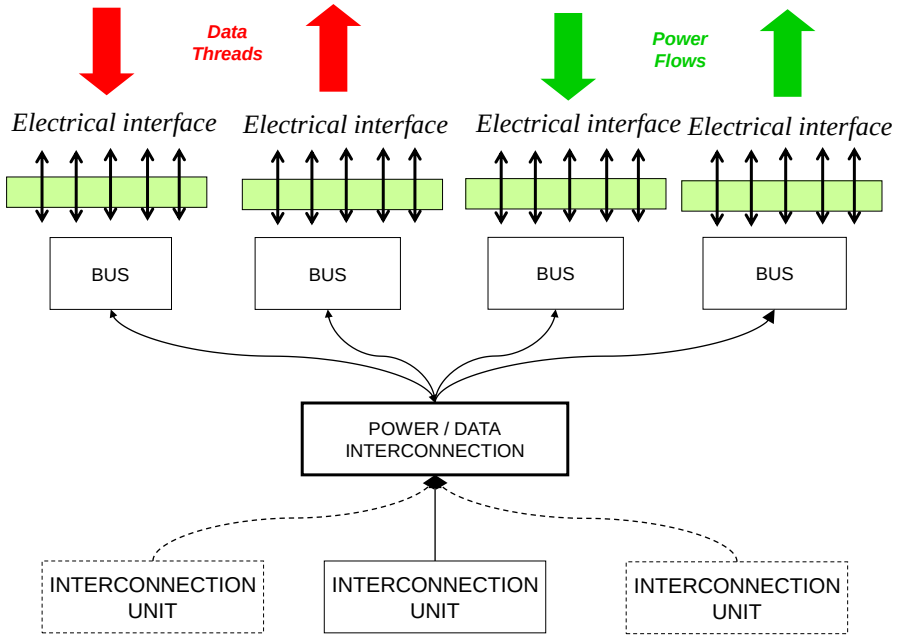

Figure 11: CLASS RH Interconnection elements relationship

4.2 Characterisation requirements for ETSO-2C153 CLASS RH (F3) Interconnection

RH.z) The characterisation shall include attenuation profiles, signal integrity, cross-talk and tolerance rates. These shall be valued and guaranteed.

RH.aa) The performances of each type of buses provided in a) shall be characterised, valued and guaranteed.

RH.bb) For at least the following failure modes, the failure rate shall be provided:

a. Loss of the interconnection function;

b. Erroneous behaviour of interconnection function.

RH.cc) The characterisation shall address the safety aspects of sequencing, delay, corruption and impersonation.

RH.dd) The characterisation shall include the list of types of buses, the associated attributes, their configurability, and their sizing and performances.

5 Requirements for Temperature control (F4)

F4 is an optional subfunction of ETSO-2C153 CLASS RH (F4): Temperature control

In this case, IMA module provides the capacity to control temperature inside the Rack for each mounted module.

This control may be realised by:

- distributing Airflow between aircraft environment (outside the rack) and the mounted hardware modules inside the IMA module (rack).
- enforcing Airflow (convection) with cooling generation unit.
- facilitating conduction between mounted hardware modules and heat sinkers part of the Rack module.

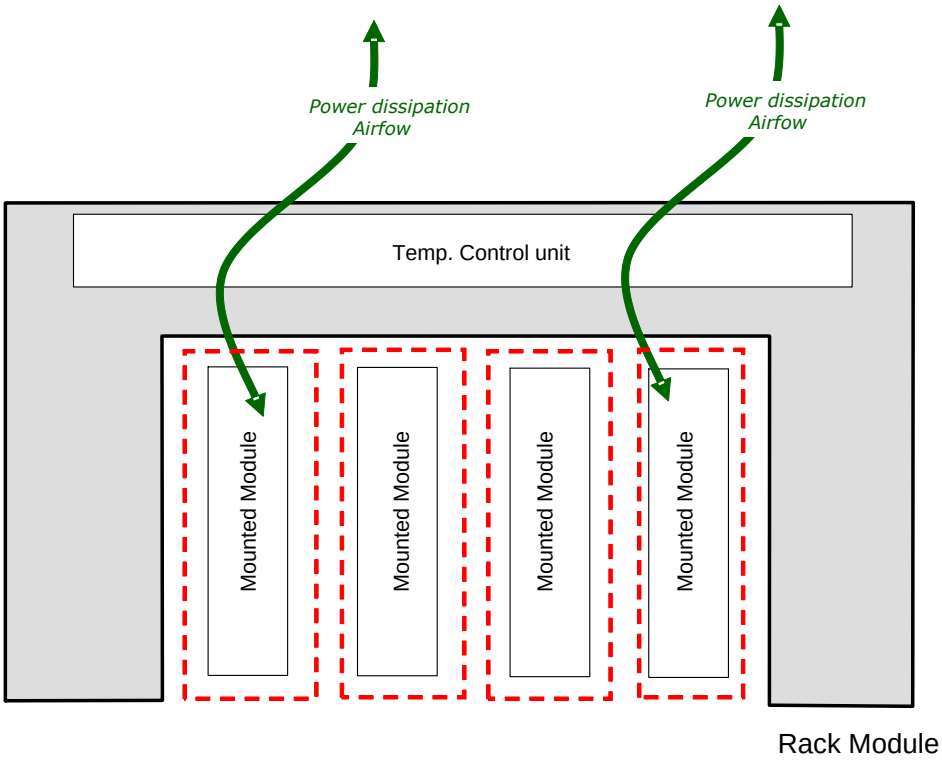

Figure 12: CLASS RH cooling function overview

5.1 Functional requirements for ETSO-2C153 CLASS RH (F4): Temperature control

RH.ee) The IMA module shall regulate temperature of the mounted hardware module. This control shall be realised per slot basis. The IMA module shall guarantee a cooling performance per slot.

RH.ff) The IMA module may provide an active means – named temperature control unit – to control temperature between aircraft environment and the mounted hardware modules.

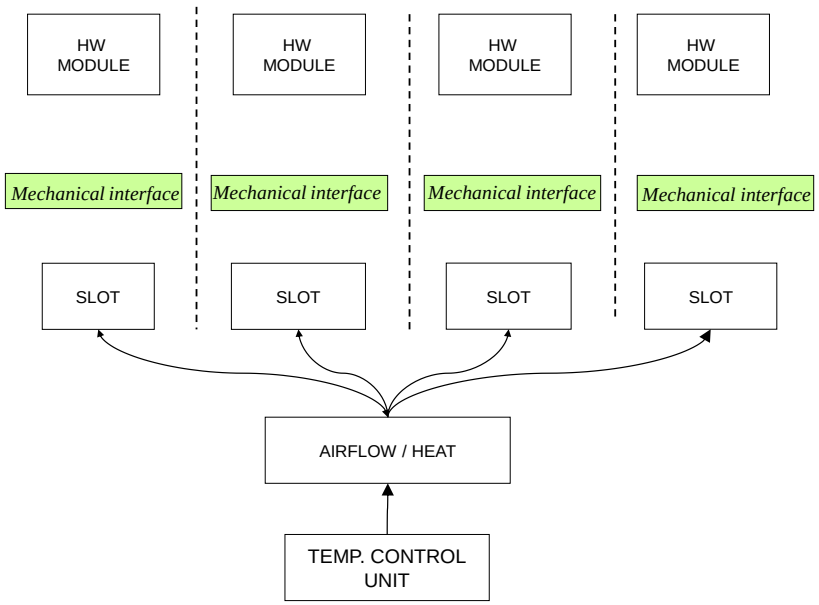

Figure 13: CLASS RH Cooling elements relationship

5.2 Characterisation requirements for ETSO-2C153 CLASS RH (F4)

RH.gg) The heat exchange performance of each slot provided shall be characterised, valued and guaranteed in the installation manual.

RH.hh) For at least the following failure modes, the failure rate shall be provided:

c. Loss of the active temperature control function;

d. Erroneous behaviour of the active temperature control function.

RH.ii) The characterisation shall address the safety aspects of partial loss and too low performance.

RH.jj) The characterisation shall include a list of types of slots, their associated attributes, their configurability and their performances in terms of heat exchange with and without the active temperature control function.

6 Verification procedures

The following table gives the verification method for each MPS; nevertheless, an alternative method may be proposed to the certification authority:

Requirement identifier	Verification method	Test under normal conditions	Test under environmental conditions	Applicable DO-160 sections
RH.a)	T	Y		
RH.b)	T	Y	Y	ED-14 sections 4, 5, 7, 8
RH.c)	T	Y	Y(2)	no ED-14 section see (2)
RH.d)	T	Y	Y	
RH.e)	T	Y		
RH.f)	I			
RH.g)	I			
RH.h)	I+A T for RH.h 4)		Y	ED-14 sections 4 and 5
RH.i)	A			

Requirement identifier	Verification method	Test under normal conditions	Test under environmental conditions	Applicable DO-160 sections
RH.j)	I+T	Y		
RH.k)	I			
RH.l)	I			
RH.m)	T	Y	Y	Appropriate ED-14 sections addressing the shielding characteristics, and as a minimum sections 18, 19, 20, 22
RH.n)	I+A			
RH.o)	I			
RH.p)	I			
RH.q)	I+A T for RH.q 4.	Y	Y	ED-14 section 20
RH.r)	I			
RH.s)	T	Y	Y	Appropriate ED-14 sections addressing the shielding characteristics and as a minimum sections 18, 19, 20, 22
RH.t)	I			
RH.u)	T	Y	Y(1)	ED-14 sections 4, 5, 6, 7, 8, 16 to 22
RH.v)	A+T	Y	Y	ED-14 sections 16 to 22
RH.w)	T	Y	Y(1)	ED-14 sections 4, 5, 7, 16 to 22
RH.x)	T	Y	Y	ED-14 sections 4, 5, 7
RH.y)	A			
RH.z)	T(A*)	Y		
RH.aa)	T(A*)	Y(1)	Y(1)	ED-14 sections 4, 5, 7
RH.bb)	A	Y		
RH.cc)	T(A*)	Y(1)		
RH.dd)	I			
RH.ee)	T	Y	Y	ED-14 sections 4 and 5
RH.ff)	I+T	Y	Y	ED-14 sections 4 and 5
RH.gg)	I+T	Y	Y	ED-14 sections 4, 5, 6, 7
RH.hh)	A			
RH.ii)	I+A			
RH.jj)	I+T(A*)	Y	Y	

Table 3 : Verification Acceptance Criteria

(A*): means that verification by Analysis method is possible for the item that cannot be tested.

Note (1): applicable for a functional subset → cf. CO.gg).
Note (2): test to be completed after environmental testing.

APPENDIX 2.3

INTEGRATED MODULAR AVIONIC PLATFORM AND MODULE MINIMUM PERFORMANCE SPECIFICATION (MPS)

CLASS PR: Processing

1. Purpose and scope

1.1. Introduction

This Appendix contains Minimum Performance Standards (MPS) for CLASS PR Intended Function: Processing (PR).

These standards specify characteristics that should be useful to designers, manufacturers, installers and users of the IMA module.

1.2. Definitions

For ETSO-2C153 CLASS PR, IMA module provides shared resources in terms of processing between IMA applications, modules and/or components.

Following definitions are used:

- Processing Unit: set of physical components (hardware and/or software) in charge of carrying out the instructions of a computer programme by performing the basic arithmetical, logical, and input/output operations of the Executable Object Code.
- Executable Object Code [EUROCAE ED-12C/RTCA DO-178C]: a form of code that is directly usable by the processing unit of the target computer and is, therefore, a compiled, assembled, and linked binary image that is loaded into the target computing hardware.
- Processing Element: well-defined set of instructions which is a primary form of Executable Object Code execution and for which a level of isolation would be guaranteed by the IMA module.

In the context of PR class, the 'concurrent item' defined in Appendix 2.1 paragraph 1 means 'Processing Element'.

1.3. Intended Function

For ETSO-2C153 CLASS PR, the intended function is to provide **the capacity to share processing** supplied by one or several processing unit(s).

IMA module may include data storage and interfaces between IMA applications, modules and/or components; in this case, this class shall be combined with DS and IF classes.

The following figure provides an overview of the intended function of the previously mentioned IMA module and associated definitions:

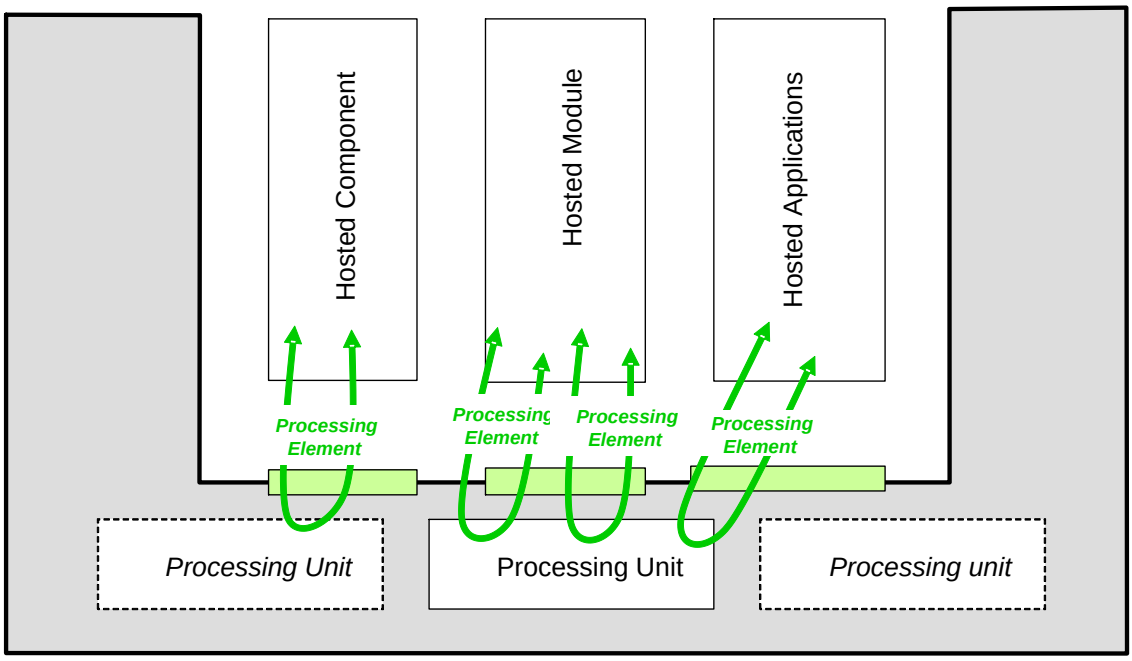

Figure 14: IMA module overview for ETSO-2C153 CLASS PR

2. Requirements

2.1. Functional requirements for ETSO-2C153 CLASS PR

PR.a) The IMA module shall provide to IMA applications, modules and/or components Processing Resource which is the capacity to execute a set of instructions of a computer programme by performing the basic arithmetical, logical, and input/output operations of their Executable Object Code(s);

PR.b) The IMA module shall be able to host IMA applications, modules or Executable Object Code(s) components.

PR.c) The IMA module shall provide to IMA applications, modules and/or components the capacity to share Processing Resource thanks to Processing Elements managed through a logical interface (such as an API).

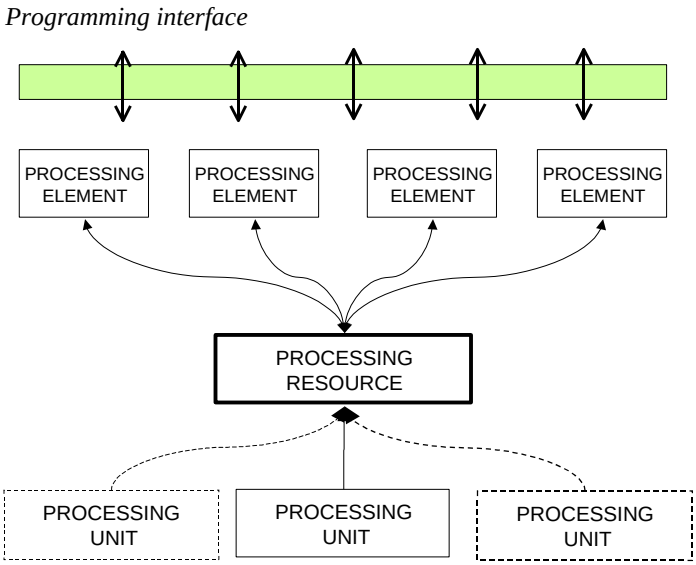

Figure 2: CLASS PR Processing elements relationship

2.2. Characterisation requirements for ETSO-2C153 CLASS PR

PR.d) All processing performances of the shared functions of the IMA module shall be characterised, including but not limited to the following:

1. Processing Unit Throughput (performance capacities and timings).
2. Performances of User Software/Software Interface (Core Software) Mechanism(s), Protocol(s), and Service(s).
3. Performances of User Hardware/Software Interface Mechanism(s), Protocol(s) and Service(s).
4. Performances of supported Processing Element Type (e.g. application, partition, process, thread, etc.).
5. Performances of Interrupt mechanisms.
6. Performances of Memory Management, including cache and MMU.

Note: These performance requirements are additional to those applicable in COMMON - Appendix 2.1).

3. Verification procedures

The following table gives the verification method for each MPS: nevertheless, an alternative method may be proposed to the certification authority:

Requirement identifier	Verification method	Test under normal conditions	Test under environmental conditions	Comment
PR.a)	T	Y	Y	
PR.b)	T	Y	Y	
PR.c)	T	Y	Y	
PR.d)	T (A*)	Y	Y(1)	

Table 4 : Verification Acceptance Criteria

(A*): means that verification by Analysis method is possible for the item that cannot be tested.

Note (1): applicable for a functional subset → cf. CO.gg)

APPENDIX 2.4

INTEGRATED MODULAR AVIONIC MODULE
MINIMUM PERFORMANCE SPECIFICATION (MPS)

CLASS GP: Graphical Processing

1. Purpose and scope

1.1. Introduction

This Appendix contains Minimum Performance Specification (MPS) for CLASS GP Intended Function: Graphical Processing.

These standards specify characteristics that should be useful to designers, manufacturers, installers and users of the IMA module.

1.2. Definitions

For ETSO-2C153 CLASS GP, IMA module provides shared resources in terms of graphical conversion and graphical laying out between IMA applications, modules and/or components based on commands coming from these IMA applications, modules and/or components.

The following definitions are used:

- Graphical Thread: set of graphical (displayable) information for which a level of isolation would be guaranteed by the IMA module.
- Data Thread: well-defined set of data which is a primary form of drawing directives received as input by the IMA module from IMA applications, modules and/or components.
- Command Thread: well-defined set of command directives received as input by the IMA module from IMA applications, modules and/or components in order to change the conversion and laying out settings.
- Graphical conversion: Transformation of a set of data information that is the primary form of drawing directives (data thread) into a set of displayable basic information.
- Laying out: Operation consisting in a combination of merging or/and splitting actions on displayable basic information in order to build the final Graphical Thread to be rendered.
- Conversion Unit: set of physical components (hardware and/or software) in charge of graphical conversion.
- Laying out Unit: set of physical components (hardware and/or software) in charge of laying out.

Note:

- Both units can be merged in one unit.
- The final rendering of the graphical thread(s) is out of the scope of this module (refer to CLASS DH).

In the context of GP class, the 'concurrent item' defined in Appendix 2.1 paragraph 1 means 'Graphical and/or Command Thread'.

1.3. Intended Function

For ETSO-2C153 CLASS GP, the intended function is to provide **the capability to share graphical conversion and graphical laying out** supplied by one or several graphical conversion and graphical laying out unit(s).

The function of the Graphical Processing Module is to receive commands from IMA applications, modules and/or components and optionally receive video from external analog or digital sources, to process them, and to generate an image to display.

This intended function is Graphical Conversion and Laying out resource sharing composed of:

- Information acquisition & control,
- Information conversion and laying out,
- Information forwarding & control.

The following figure provides an overview of the previously mentioned IMA module intended function and associated definitions:

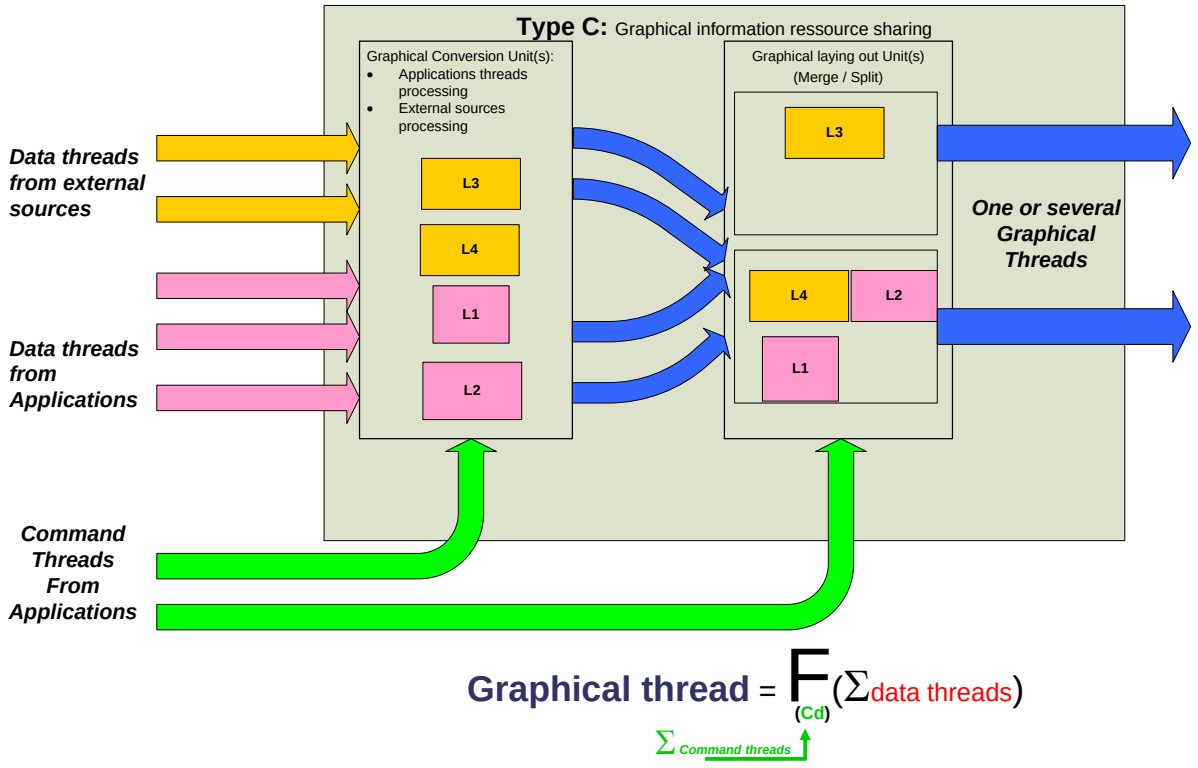

Figure 15: IMA module overview for ETSO-2C153 CLASS GP

2. Requirements

2.1. Functional requirements for ETSO-2C153 CLASS GP:

GP.a) The IMA module shall provide to IMA applications, modules and/or components Graphical Conversion Resource which is the capability to transform a set of drawing directives into a set of displayable basic information.

GP.b) The IMA module shall provide to IMA applications, modules and/or components Graphical Laying out Resource which is the capability to merge or/and split displayable basic information to build the final Graphical Thread(s) to be rendered.

GP.c) The IMA module shall provide to IMA applications, modules and/or components the capability to change the graphical conversion and laying out settings through command threads.

GP.d) The IMA Module shall provide to IMA applications, modules and/or components the capability to share a Graphical Conversion Resource and a Graphical Laying out Resource based on command threads managed through logical and/or physical interface(s).

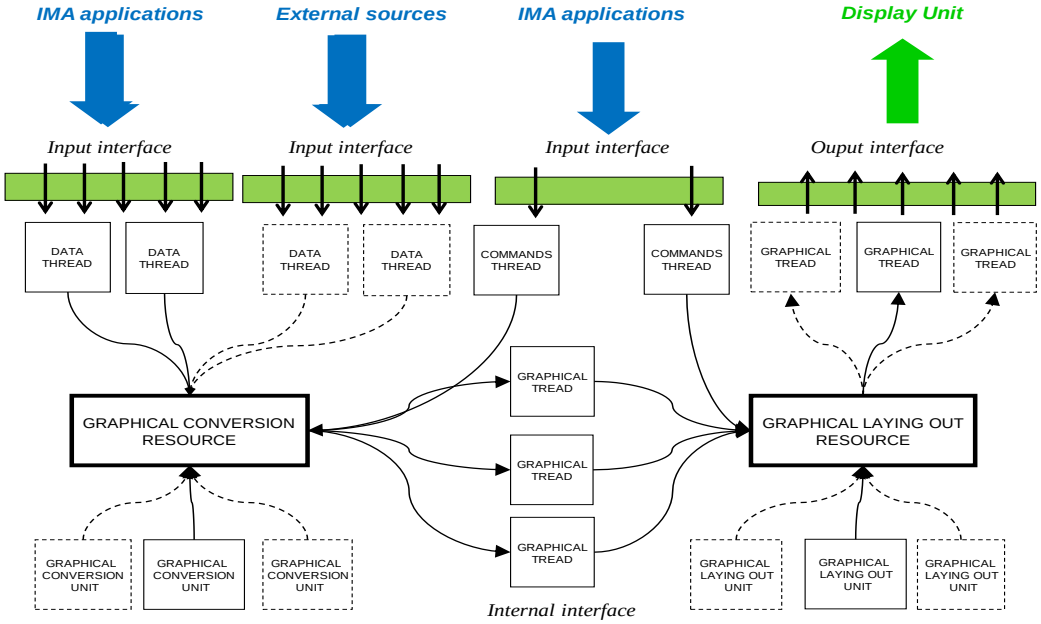

Figure 16: CLASS GP Graphical Processing (GP) elements relationship

2.2. Characterisation requirements for ETSO-2C153 CLASS

GP.e) Following the Graphical Unit(s) performances of the IMA module shall be valued and guaranteed:

1. Graphical Unit(s) Throughput (performance capacities and timings: response time, graphical update).
2. Performances of User Software/Software Interface (Core Software) Mechanism(s), Protocol(s), and Service(s).
3. Performances of User Hardware/Software Interface Mechanism(s), Protocol(s) and Service(s).
4. Performances of Interrupt mechanisms.
5. Performances of supported Data Thread types.
6. Performances of supported Graphical Thread types.
7. Performances of supported Command Thread types.

Note: These performance requirements are additional to those applicable in COMMON - Appendix 2.1).

GP.f) In addition to Common Requirement CO.w), particular emphasis should be given to precluding or mitigating failures which could result in hazardously misleading information. Undetected loss of information or frozen information could contribute to hazardously misleading information.

3. Verification procedures

The following table gives the verification method for each MPS; nevertheless, an alternative method may be proposed to the certification authority:

Requirement identifier	Verification method	Test under normal conditions	Test under environmental conditions	Comment
GP.a)	T	Y	Y	
GP.b)	T	Y	Y	
GP.c)	T	Y	Y	
GP.d)	T	Y	Y	
GP.e)	T(A*)	Y	Y(1)	
GP.f)	I			

Table 5 : Verification Acceptance Criteria

(A*): means that verification by Analysis method is possible for the item that cannot be tested.

Note (1): applicable for a Functional subset → cf. CO.gg).

APPENDIX 2.5

INTEGRATED MODULAR AVIONIC PLATFORM MODULE MINIMUM PERFORMANCE SPECIFICATION (MPS)

CLASS DS: Data Storage (DS)

1. Purpose and scope

1.1. Introduction

This Appendix contains Minimum Performance Standards (MPS) for CLASS DS Intended Function: Data Storage.

These standards specify characteristics that should be useful to designers, manufacturers, installers and users of the IMA module.

1.2. Definitions

For ETSO-2C153 CLASS DS, IMA module provides shared resources in terms of data storage between IMA applications, modules and/or components.

Data Storage refers to the storage of data in a persisting and machine-readable mode. Data Storage module that records data may access both separate portable (removable) recording component and/or permanent component to store and retrieve data.

Following definitions are used:

- Storage Unit: set of physical components (hardware and/or software) in charge of supplying and managing recorded data resource (e.g. memory components and associated interfaces, etc.)
- Data Storage Element: completely defined set of data storage which is a primary form of recorded data and for which a level of isolation would be guaranteed by the IMA module.

In the context of DS class, the 'concurrent item' defined in Appendix 2.1 paragraph 1 means 'Data Storage Element'.

1.3. Intended Function

For ETSO-2C153 CLASS DS, the intended function is to provide **the capability to share recorded data or data storage space** supplied by one or several storage unit(s).

2. Requirements

2.1 Functional requirements for ETSO-2C153 CLASS DS:

DS.a) The IMA module shall provide to IMA applications, modules and/or components Data Storage Resource which is the capacity to record or to retrieve a set of data on/from a storage unit by performing the data-retaining operations.

DS.b) The IMA module shall provide to IMA applications, modules and/or components the capacity to use shared recorded data resource thanks to data storage elements accessible through a logical and/or physical interface(s).

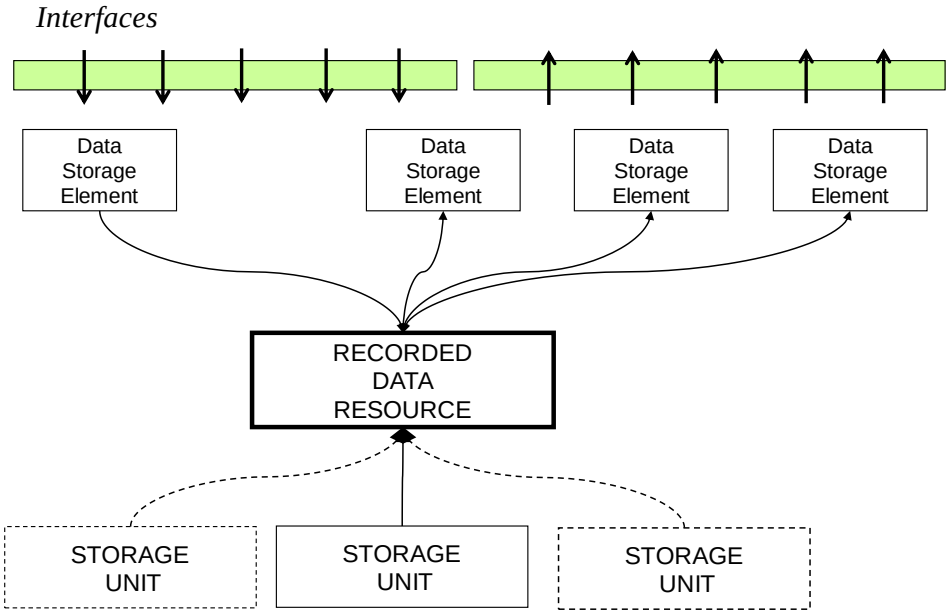

Figure 17: CLASS DS Data Storage elements relationship

2.2 Characterisation requirements

DS.c) All Data Storage performances of the shared functions of the IMA module shall be characterised including but not limited to the following:

1. Performances of Memory Management, including cache and Memory Management Unit (e.g. storage capacity, cache performances, etc.).
2. Performances of User Interface Mechanism(s), Protocol(s) and Service(s) (e.g. access timings and throughputs, etc.)
3. Performances of supported Data Storage Element Type (e.g. namespace, address scheme, arbitrary principles for multiple access, throughputs, timings, data space, etc.).

Note: These performance requirements are additional to those applicable in COMMON - Appendix 2.1.

3. Verification procedures

The following table gives the verification method for each MPS; nevertheless, an alternative method may be proposed to the certification authority:

Requirement identifier	Verification method	Test under normal conditions	Test under environmental conditions	Comment
DS.a)	T	Y	Y	
DS.b)	T	Y	Y	
DS.c)	T(A*)	Y	Y(1)	

Table 6 : Verification Acceptance Criteria

(A*): means that verification by Analysis method is possible for the item that cannot be tested.

Note (1): applicable for a functional subset → cf. CO.gg).

APPENDIX 2.6

INTEGRATED MODULAR AVIONIC MODULE MINIMUM PERFORMANCE SPECIFICATION (MPS)

CLASS IF: Interface

1. Purpose and scope

1.1. Introduction

This Appendix contains Minimum Performance Standards (MPS) for CLASS IF Intended Function: Interface.

These standards specify characteristics that should be useful to designers, manufacturers, installers and users of the IMA module.

1.2. Definitions

For ETSO-2C153 CLASS IF, IMA module provides shared resources in terms of interfaces between IMA applications, modules and/or components.

Following definitions are used:

- Interface Unit: set of physical components (hardware and/or software) in charge of supplying and managing a shared information resource.
- Data Thread: well-defined set of data which is a primary form of information and for which a level of isolation would be guaranteed by the IMA module.

Each data thread handled by the Interface, if so wished bytghe applicant, may be bidirectional or symmetrical between interconnected components, modules, or IMA applications.

In the context of IF class, the 'Concurrent item' defined in Appendix 2.1 paragraph 1 means 'Data Thread'.

1.3. Intended Function

For ETSO-2C153 CLASS IF, the intended function is to provide **the capability to share information** supplied by one or several interfaces units.

This intended function is Information Sharing composed of:

- information acquisition & control,
- information conversion and,
- information forwarding & control.

The information-forwarding and control function is the means that allows sharing information between components, modules and/or IMA applications.

The following figure provides an overview of the previously mentioned intended function and associated definitions:

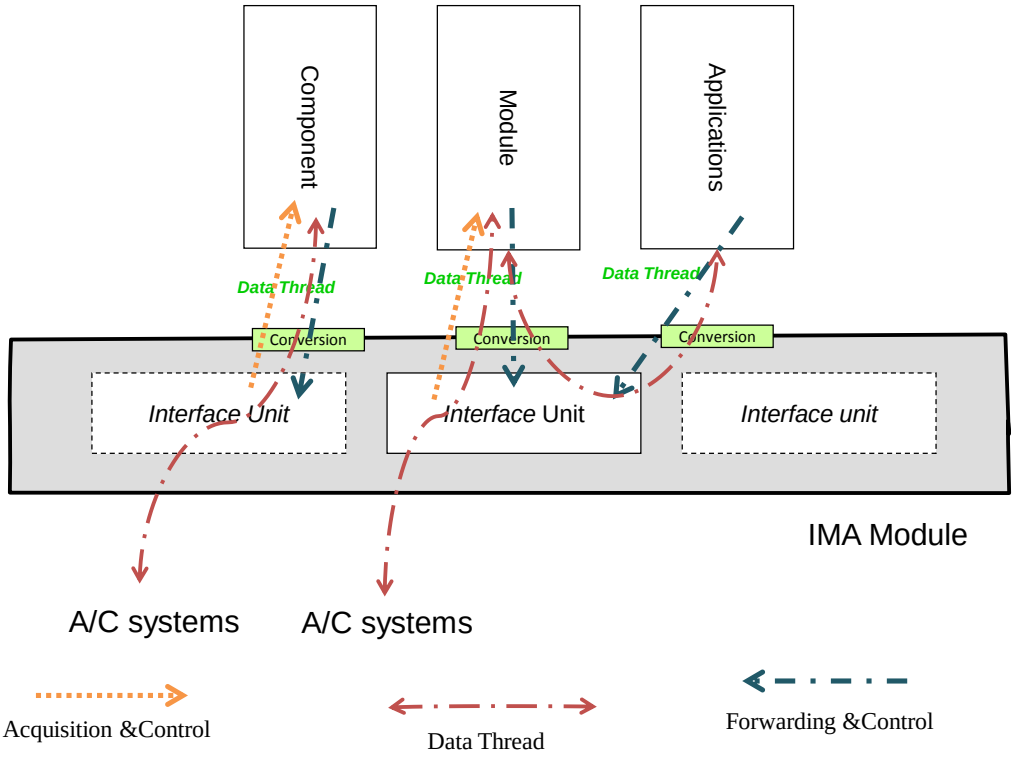

Figure 18: IMA module overview for ETSO-2C153 CLASS IF

2. Requirements

For ETSO-2C153 CLASS IF, IMA module provides shared resources for communication needs of IMA applications, modules and/or components.

2.1. Functional requirements for ETSO-2C153 CLASS IF:

IF.a) The IMA module shall provide to IMA applications, modules and/or components Information Resource which is the capacity to acquire or to forward a set of data from/to an interface unit by performing the information coding and decoding operations.

IF.b) The IMA module shall provide to IMA applications, modules and/or components the capacity to use shared Information Resource thanks to Data Threads handled through logical and/or physical interface(s).

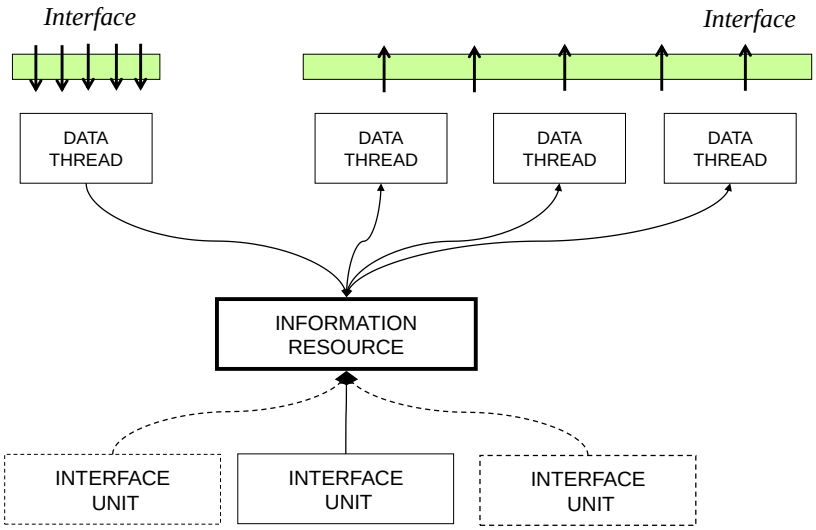

Figure 19: CLASS IF Interfaces (IF) elements relationship

2.2. Characterisation requirements for ETSO-2C153 CLASS IF:

IF.c) All performances of the shared functions of the IMA module shall be characterised including but not limited to the following:

1. Performances of each Interface, including throughput, acquisition speed, forwarding speed, latency, jitter, coding rate and decoding rate.
2. Performances of User Interface Mechanism(s), Protocol(s) and Service(s) (e.g. socket timing, communication port timing, technological time delay,etc).
3. Performances of supported Data Thread Type (e.g. virtual link, channel, pipe-and-filter, physical connection pin, etc.).

Note: These performance requirements are additional to those applicable in COMMON - Appendix 2.1).

IF.d) In addition to Common Requirement CO.w), the characterisation shall address the safety aspects of frozen data.

3. Verification procedures

The following table gives the verification method for each MPS; nevertheless, an alternative method may be proposed to the certification authority:

Requirement identifier	Verification method	Test under normal conditions	Test under environmental conditions	Comment
IF.a)	T	Y	Y	
IF.b)	T	Y	Y	
IF.c)	T(A*)	Y	Y(1)	
IF.d)	T or A*			

Table 7: Verification Acceptance Criteria (A*): means that verification by Analysis method is possible for the item that cannot be tested.

Note (1): applicable for a functional subset → cf. CO.gg).

APPENDIX 2.7

INTEGRATED MODULAR AVIONIC PLATFORM MODULE
MINIMUM PERFORMANCE SPECIFICATION (MPS)

CLASS PS: Power Supply (PS)

1. Purpose and scope

1.1 Introduction

This document contains Minimum Performance Standards (MPS) for CLASS PS Intended Function: Power Supply (PS)

These standards specify module characteristics that should be useful to designers, manufacturers, installers and users of the module.

1.2 Definitions

For ETSO-2C153 CLASS PS, IMA module is a module **mounted into a rack** which is able to supply power received from aircraft electrical network to one or more hardware modules mounted in the same rack.

Following definitions are used:

- Power supply unit: set of physical components (hardware and or software) in charge of managing a power supply (or a part of the power supply) resource.
- Power supply resource : obtained electrical energy from aircraft electrical network to be distributed to electrical loads which are modules mounted into the rack
- Power rail: part of supplied electrical energy for which a level of isolation would be guaranteed by the IMA module.
- Mounted: is said for a hardware module fixed inside the Rack Module after a human operation in aircraft.
- Slot : the physical envelop dedicated to one mounted hardware module inside the Rack Module
- Hold-up Capacity. The capacity of the power supply to continue supplying output current after the input voltage drops below the minimum level. This is usually expressed as the time from the input voltage drop to the reset generated by the power supply to the processor.
- Output Current Capacity. The continuously operating maximum current supplied for each output voltage.
- Power Monitors & Status Outputs. Separate circuitry which checks the output voltage levels and current loading of the power supply. This circuitry will generate one or more binary signals that may be connected to the processor to alert it to the "out of spec" condition. These binary signals may also force the power supply to shut-down to prevent damage to power supply components.
- Power Resets. A binary signal output from the power supply that is asserted when the output voltages are outside acceptable tolerances.

- Regulation. The percentage of variation of the output voltages when subjected to changes in load, changes in temperature, and all input voltage transients and deviations.
- Transient Immunity. The ability of the power supply to continue operating normally during variations in the input voltage. This is usually expressed as the length of time and the voltage level of the transient.
- Voltage Outputs and Tolerances. The voltage levels and tolerances of the outputs produced by the power supply.

In the context of PS class, the "concurrent item" defined in Appendix 2.1 paragraph 1 means 'Power Rail'.

1.3 Intended Function

For ETSO-2C153 CLASS PS, the intended function is to provide **the capability to share Power Supply resource** supplied by one of more Power Supply unit(s).

The following figure provides an overview of the previously mentioned intended function and definitions:

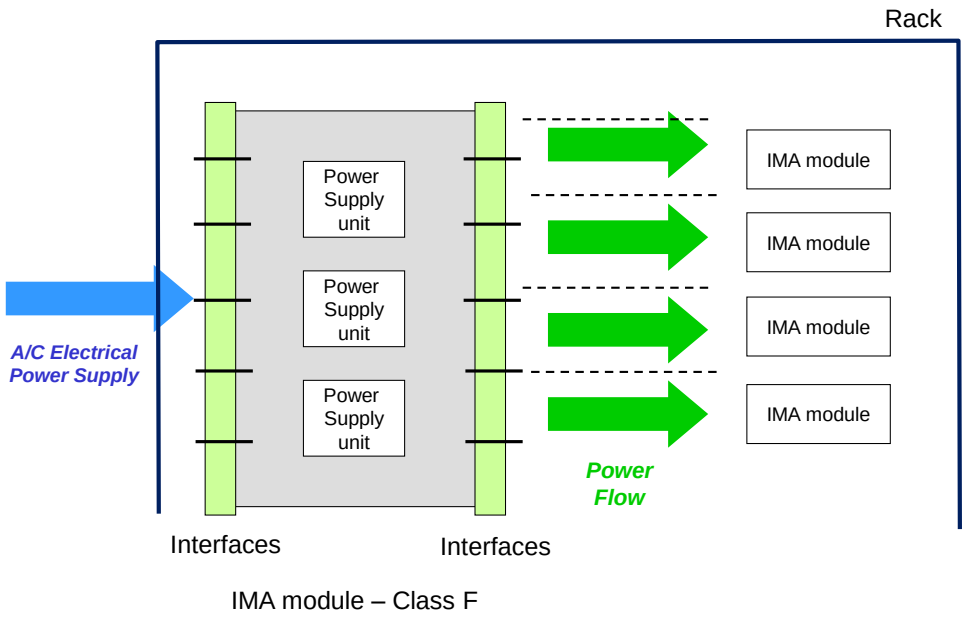

Figure 20: IMA module overview for ETSO-2C153 CLASS PS

2. Requirements

2.1 Functional requirements for ETSO-2C153 CLASS PS:

PS.a) The IMA module, mounted into a rack, shall provide to hardware modules, mounted into the same rack, Power Supply Resource which is the capacity to deliver a quantity of electrical energy from power supply unit(s) to the hardware modules while performing the regulation operations.

PS.b) Mounted into a rack, the IMA module shall provide to hardware modules, which are mounted into the same rack, the capacity to share power supply resource thanks to power rails accessible through physical interface(s).

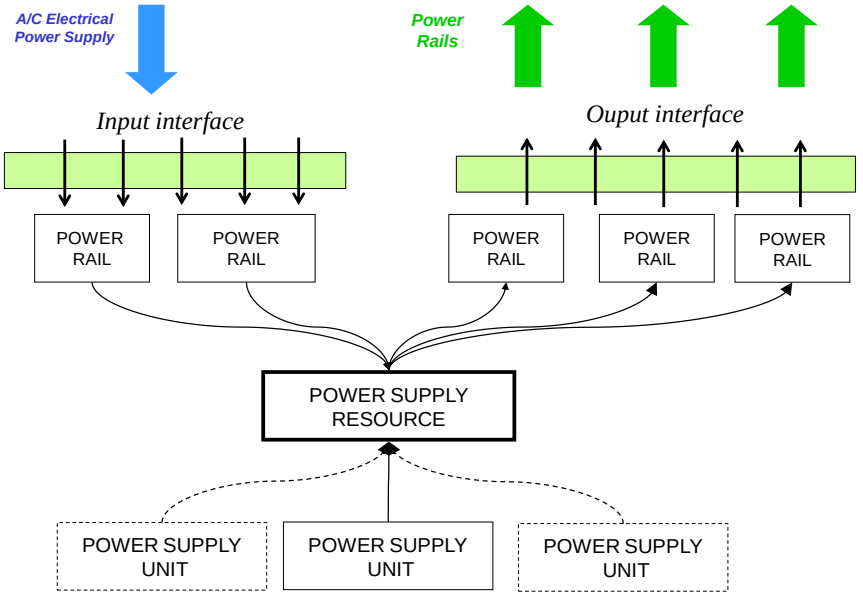

Figure 21: CLASS PS (PS) elements relationship

2.2 Characterisation requirements

PS.c) All Power Supply performances of the shared functions of the IMA module shall be characterised including but not limited to the following:

1. Efficiency (delivered power versus input power) characteristics (e.g. in function of Temperature and load)
2. Performances of Output Current and Tolerances;
3. Performances of Hold-up Capacity;
4. Performances of Power Monitors and Status Outputs;
5. Performances of Power Resets;
6. Performances of Regulation;
7. Performances of Transient Immunity;
8. Performances of Voltage Outputs and Tolerances;
9. Performances of User Interface Mechanism(s), Protocol(s) and Service(s);
10. Performances of supported Power rail Type;
11. Input and Output impedance.

Note: These performance requirements are additional to those applicable and dictated by the design of IMA module itself (according to COMMON Requirement in Appendix 2.1).

PS.d) In addition to Common Requirement CO.w), the characterisation shall address the safety aspects of events such as too low voltage or current, too high voltage or current. Transient as well as permanent effects shall be characterised if relevant.

PS.e) The characterisation shall provide any data needed to evaluate power profile characteristics (e.g. Maximum Value, In-Rush current) of managed power rails and IMA module power on/power off behaviour characteristics.

3. Verification procedures

The following table gives the verification method for each MPS; nevertheless, an alternative method may be proposed to the certification authority:

Requirement identifier	Verification method	Test under normal conditions	Test under environmental conditions	Comment
PS.a)	T	Y	Y	
PS.b)	T	Y	Y	
PS.c)	T(A*)	Y	Y(1)	
PS.d)	T(A*)	Y		
PS.e)	A			

(A*): means that verification by Analysis method is possible for the item that cannot be tested.

Note (1): applicable for a functional subset → cf. CO.gg).

APPENDIX 2.8

INTEGRATED MODULAR AVIONIC PLATFORM MODULE
MINIMUM PERFORMANCE SPECIFICATION (MPS)

CLASS DH: Display Head

1. Purpose and scope

1.1 Introduction

This Appendix contains Minimum Performance Standards (MPS) for CLASS DH Intended Function: Display Head.

These standards specify characteristics that should be useful to designers, manufacturers, installers and users of the module.

1.2 Definitions

For ETSO-2C153 CLASS DH, IMA module provides shared resources in terms of display area between IMA Applications, components and/or modules.

Following definitions are used:

- Display Unit: set of physical components (hardware and/or software) in charge of managing a display area (or a part of a display area).
- Display Area: Surface where some visual information can be depicted by one or several Display Unit(s) based on received Graphical Threads.
- Graphical Thread: set of graphical information received as input by the Display Head from one or more IMA Application(s), component(s) and/or module(s).
- Display Thread: set of depiction information for which level of isolation would be guaranteed on the Display Area by the Display Head.

In the context of DH class, the 'Concurrent item' defined in Appendix 2.1 paragraph 1 means 'Display Head'.

1.3 Intended Function

For ETSO-2C153 CLASS DH, the intended function is to provide the capability to share one display area supplied by one or several display unit(s).

The intended function of such IMA module is to offer the capability to depict graphical information received from IMA Application(s), component(s) and/or module(s) on one Display Area.

The following figure provides an overview of the previously mentioned intended function and associated interfaces:

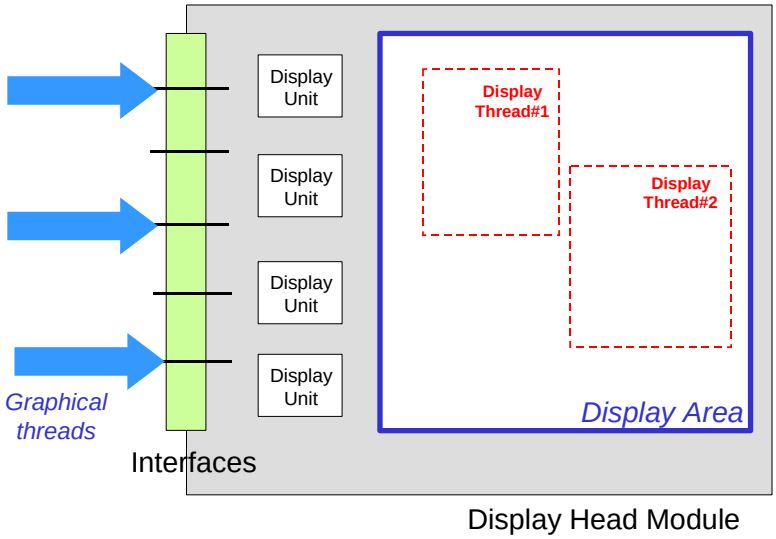

Figure 22: IMA module overview for ETSO-2C153 CLASS DH

2. Requirements

2.1 Functional requirements for ETSO-2C153 CLASS DH:

DH.a) The IMA module shall provide to IMA applications, modules and/or components Display Area Resource which is the capability to render visual graphical information.

DH.b) The IMA module shall be compliant (fully or partially) to MPS from applicable release of ETSO C-113.

Note: These performance requirements are additional to those applicable in COMMON - Appendix 2.1.

DH.c) The IMA module shall provide to IMA Applications, modules and/or components the capability to share a Display Area resource managed through a logical or physical interface.

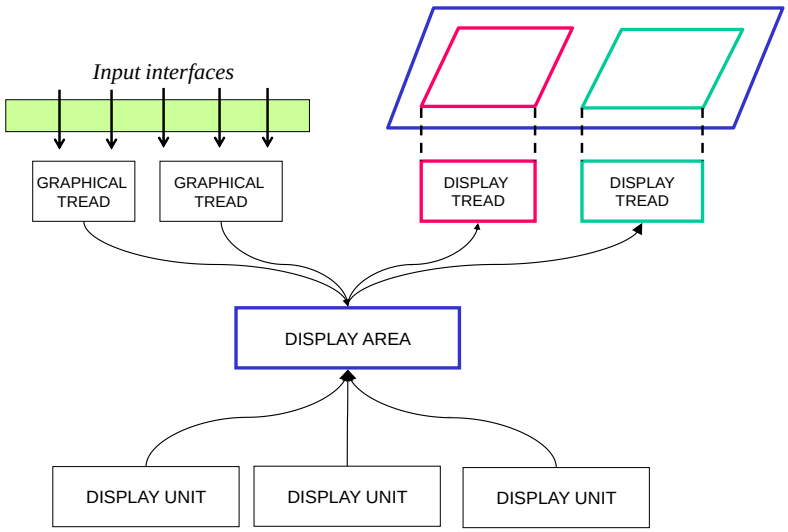

Figure 23: CLASS DH Display Head elements relationship

2.2 Characterisation requirements for ETSO-2C153 CLASS DH:

DH.d) In addition to Common Requirement CO.w), the characterisation shall address the safety aspects of delay and/or frozen information.

DH.e) In addition to Common Requirement CO.s), the characterisation shall include any data needed to evaluate Worst Case Display Elaboration Time of managed threads and characteristics required by applicable release of SAE AS8034 (per applicable revision of ETSO-C113).

DH.f) The additional activities to be performed by the users related to applicable release of ETSO-C113 compliance demonstration completeness shall be included in the characterisation for gap identification.

3. Verification procedures

The following table gives a verification method for each MPS; nevertheless, an alternative method may be proposed to the certification authority:

Requirement identifier	Verification method	Test under normal conditions	Test under environmental conditions	Comment
DH.a)	T	Y	Y	
DH.b)	(2)	(2)	(2)	
DH.c)	T	Y	Y	
DH.d)	T/A*	Y		
DH.e)	A			
DH.f)	A			

Table 8 : Verification Acceptance Criteria

(A*): means that verification by Analysis method is possible for the item that cannot be tested.

Note (1): for the functional subset see CO.gg).

Note (2): applicable revision of ETSO-C113 is defining the verification requirements of a display function.

APPENDIX 3

INTEGRATED MODULAR AVIONIC MODULE DATA REQUIREMENTS

For IMA module authorisation, as mentioned in paragraph 2.2 of the document body, additional technical data shall be available or submitted. This data will be documented into a set of documents for both the Airworthiness Authority (qualification plans, compliance evidences, etc.) and the IMA module users such as Application developers, Integrator or Type Certificate applicant (User Guide, Usage domain, etc.):

- Chapter 1 - IMA module ED-124 documentation
- Chapter 2 - Specific User Guide and Installation Manual contents
- Chapter 3 - Core software
- Chapter 4 - Health management and reporting
- Chapter 5 - Usage domain
- Chapter 6 - Configuration
- Chapter 7 - Tools
- Chapter 8 - Compatibility & mixability information

Chapter 1 – IMA module ED-124 documentation

IMA system approval can be made incremental by introducing some intermediate acceptance steps. ETSO-2C153 authorisation is a first intermediate step dedicated to authorise IMA platform or IMA modules (independently of any specific aircraft installation).

EUROCAE ED-124/RTCA DO-297 contain guidance for Integrated Modular Avionics (IMA) developers, application developers, integrators, certification applicants, and those involved in the approval and continued airworthiness of IMA systems in civil certification projects.

As mentioned in paragraph 3.2.2.1 of the document body, to prepare the integration of the ETSO-2C153 IMA module, the development objectives are defined in EUROCAE ED-124 guidance related to task 1 (Table A-1 objectives).

The following data are available (A) or submitted (S) to the competent authority for ETSO-2C153 approval:

EUROCAE ED-124 Life Cycle Data	EUROCAE ED-124 Life Cycle Section	Available/Submitted (A) / (S)
Module Acceptance Plan	4.2.3	S
Module Requirements Specifications	4.2.4	A
Traceability Data	4.2.5	A
Module Design Data	4.2.4	A
Module Failure Analyses and Safety Analyses	4.2.12b	S
Module Tool Qualification Data	4.2.12c	S
Partitioning Analysis Data	4.2.4j	S
V&V data	4.2.5	A
Module Acceptance Data Sheet	4.2.10	S
Interface Specifications	4.2.4f	A
Module User Guide	4.2.12e	S(*)
Module QA Records	4.2.6	A
Module CM Records	4.2.8	A
Module Acceptance Accomplishment Summary	4.2.9	S
Module Acceptance Configuration Index	4.2.7	S
Module Open Problem Reports	4.2.11	S

Note: (*) only for User Guide content used for ETSO compliance demonstration.

Chapter 2 – Specific User Guide and Installation Manual contents

As per ED-124, IMA module User's guide shall be provided by the IMA module manufacturer to both the module users and the Airworthiness Authority.

This User Guide includes all information for users, integrators, and certification applicants to successfully interface or integrate the module such as:

- Interfaces;
- Limitations and Open Problem Reports;
- Worst Case Execution Time (WCET) analysis elements;
- Core Software (see Appendix 3 – Chapter 3);
- Fault management and Health Monitoring (See Appendix 3 – Chapter 4);
- Usage Domain (See Appendix 3 – Chapter 5);
- Configuration Aspects (See Appendix 3 – Chapter 6);
- Tools aspects (See Appendix 3 – Chapter 7);
- Compatibility and mixability information (See Appendix 4 – Chapter 8);
- Requirements recommendations for Applications;
- Requirements recommendations for System Integration.

The Installation Manual includes all data necessary for the proper installation and use of the IMA module (including marking aspects).

Each item of the characterisation and functional requirements are addressed in the User Guide (or eventually in the Installation Manual, if appropriate).

The User Guide defines the usage domain for which the module acceptance data are valid.

The information includes recommendations and may also include examples for correct use. In addition, the guide highlights any warnings or limitations for integrating or interfacing the module to avoid potential incorrect or unintended use.

The User Guide may be completed by the IMA module manufacturer with:

- Information on Single Event Upset (SEU) effects;
- A Validation and Integration Kit for application developers and system integrators;
- Development and In-Service support;
- Some training.

The Installation Manual includes information as required in MPS appendix or reference subsequent applicable chapter of the User Guide. In this case, the User Guide chapter will be submitted to the Airworthiness Authority (see note (*) above).

The User Guide may be included in the Installation Manual of the IMA module (e.g. Annexes) or a separated document referenced by the Installation Manual.

Chapter 3 - Core software

As defined in Appendix 1, IMA module may be an association of hardware and Core Software.

The Core Software is constituted by the operating system and the support software that manage resources to provide an environment in which the intended function is performed. Core software is typically comprised of one or more component(s). Core Software may be resident or a Field-Loadable Software Part.

If IMA module contains Core Software, Core Software characteristics required by CO.r) in Appendix 2 are documented in the IMA module User Guide.

Chapter 4 - Health management and reporting

Data requirement related to Health Management and reporting are listed in CO.x).

Chapter 5 - IMA module usage domain

ETSO-2C153 authorisation relies on the concept of Usage Domain (as per EUROCAE ED-124 and Appendix 1 - Chapter 2 Definitions).

The usage domain of an IMA module is defined as an exhaustive list of conditions (valid use cases) to be respected by the user(s) and for which the applicant has demonstrated that the following properties are true:

- The module is compliant with its functional, performance, safety and environmental requirements specified for all implemented Intended Functions.
- The module characteristics documented in the User Guide (as required by Appendix 2) are guaranteed by manufacturer.
- The module is compliant with the applicable airworthiness requirements (including continued airworthiness aspects).

The usage domain is defined at IMA module level (ED-124 Task 1) and used at Application (EUROCAE ED-124 Task 2) and IMA system (EUROCAE ED-124 Task 3 and 4) level.

The definition of the usage domain includes consideration of the module functionality, performance and safety requirements and its required environmental performance.

The IMA module manufactured to comply with this ETSO may be used to support other ETSOs or systems approved under Certification Specifications (CS) 23, 25, 27, 29, E or P. These ETSO authorisations, IMA system approvals and aircraft-level approvals are not covered by this ETSO but will rely on the fact that compliance with Usage Domain documented in the User Guide is correctly implemented.

Chapter 6 - Configuration

IMA module may need to be configured before installation in the IMA system (EUROCAE ED-124 Task 2, 3 and 4).

Data requirement related to configurability are listed in CO.y) in Appendix 2.

Chapter 7 - Tools

IMA module may need to use some tools during installation in the IMA system (EUROCAE ED-124 Task 2, 3 and 4). These tools may be used by:

- Application developers,

- Integrator(s),
- Type Certificate or Supplemental Type Certificate Applicant.

These tools may address:

- Software development (IMA Applications);
- Configuration development;
- Network architecture and configuration;
- Debug, data-loading;
- WCET analysis and measures;

In that case, User Guide references each tool and the data listed in Appendix 2 CO.z).

If qualification credit is expected from these tools, such as configuration tools, qualification process and data requirements are defined in CS-ETSO – subpart A - paragraph 2.2 Software standards and paragraph 2.3 Airborne Electronic Hardware. Qualification data are considered as data to be submitted to EASA in the frame of ETSO-2C153 authorisation.

Chapter 8 - Compatibility and mixability information

The IMA module manufacturer provides compatibility and mixability information between hardware, software, tools and usage domain in the User Guide, as required per Appendix 2 CO.aa).

APPENDIX 4

INTEGRATED MODULAR AVIONIC MODULE ENVIRONMENTAL QUALIFICATION REQUIREMENTS

CS-ETSO Subpart A section 2.3 requires performing environmental testing according to EUROCAE ED-14/RTCA DO-160 appropriate releases.

For ETSO-2C153, some particularities have to be addressed:

- Test Software representativeness,
- Applicable Test Procedures,
- Parameters to be monitored during Environmental Qualification Test.

Chapter 1: Test Software representativeness

In the case that IMA module is qualified without the functional software installed and operating, engineering analysis from the manufacturer must determine that the Test Software (not the target functional software) is representative of the usage domain stress envelop for the environmental tests (i.e. dissipated temperature, power consumption, radiated field radiation, etc.).

Test software shall be developed to exercise the Hardware to perform the environmental tests in the worst-case conditions and/or most sensitive configurations in order to evaluate the robustness of the IMA module over the full Usage Domain. For example, Test Software should exercise all physical interfaces, maximum number of applications or input filter values should be set to the domain boundary which would be the most transparent to input electrical interferences.

Chapter 2: Applicable Test Procedures

For ETSO-2C153 authorisation, IMA module may be a single LRU platform (Line Replaceable Unit) or may be a module located into a Rack (Line Replaceable Module).

Two cases have to be considered depending on the IMA module characteristics.

- Case 1: The IMA module is a single LRU platform,
- Case 2: The IMA module is a module designed to be located in a Rack at installation.

Note: Rack Housing module is not addressed in this generic Appendix but is addressed in Appendix 2.2 Class RH - Rack Housing.

Chapter 2.1: The IMA module is a single LRU platform

In this case, the environmental sections defined in the Table below (Figure 24) are applicable to the IMA module.

The usage domain of IMA module must be defined and maintained so that all these environmental qualification tests produce a complete credit for other ETSOs authorisation (functional ones) and Type-Certificate level.

Environmental Test	ED-14/DO-160 section	Requirement for ETSO-2C153
Temperature	4.5	Mandatory
Altitude	4.6	Mandatory
Temperature Variation	5.0	Mandatory
Humidity	6.0	Mandatory
Shock (operational)	7.2	Mandatory
Shock (Crash Safety)	7.3	Mandatory
Vibration	8.0	Mandatory
Explosion Atmosphere	9.0	Optional
Waterproof	10.0	Optional
Fluids Susceptibility	11.0	Optional
Sand and Dust	12.0	Optional
Fungus Resistance	13.0	Optional
Salt Fog	14.0	Optional
Magnetic Effect	15.0	Mandatory
Power Input	16.0	Mandatory
Voltage Spike	17.0	Mandatory
Audio Frequency Conducted Susceptibility—Power Input	18.0	Mandatory
Induced Signal Susceptibility	19.0	Mandatory
Radio Frequency Susceptibility (Radiated and conduced)	20.0	Mandatory
Emission of Radio Frequency Energy	21.0	Mandatory
Lightning Induced Transient Susceptibility	22.0	Mandatory
Lightning Direct Effects	23.0	Optional
Icing	24.0	Optional
Electro Static Discharge (ESD)	25.0	Mandatory
Fire, Flammability	26.0	Optional

Figure 24 Environmental Qualification for ETSO-2C153 in case of single LRU platform

Chapter 2.2: The IMA module is a module designed to be located into a Rack at installation or the rack itself.

In this type of envisioned installation, only a minimal subset of environmental conditions is applicable to the IMA module. This minimal subset is defined as mandatory in the table below (Figure 25).

Test sections identified as optional are not required for ETSO-2C153 application. Nevertheless, the IMA module can be subjected to these test conditions on a voluntary basis. When optional sections are not tested, they shall be marked as X.

Environmental Qualification Testing will be completed after cabinet integration in the frame of other ETSOs authorisation (functional ones) and Type Certificate level.

The usage domain of the IMA module must be defined and maintained so that at least this subset of qualification tests produces some credit for other ETSOs authorisation and Type-Certificate level.

Note: It is acceptable to perform the environmental qualification on the intended rack installation equipped with mounted IMA module(s). The 2C153 IMA module should be set in worst-case

configurations. Doing so, the set of Qualification documents (Qualification Test Plans, Procedures and Reports) may be common to the rack and module ETSO-2C153 authorisations. These documents should demonstrate that the considered configurations (which may be different depending on EUROCAE ED-14/RTCA DO-160 section) are the worst-cases for the set of authorised configurations of modules within the rack. Whatever the qualification method, the authorised configuration should be specified in the installation manual(s).

Such documented authorised configurations include any installation limitations taken as hypothesis for Environmental Qualification Testing (rack part number(s), slot number(s), blade neighborhood(s), and temperature to be guaranteed) to be specified in the Installation Manual and respected by the integrator to take credit of the Environmental Qualification Testing performed at module level.

Environmental Test	**ED-14/ DO-160 section**	**Requirement for ETSO-2C153**
Temperature	4.5	Mandatory When module performance over environmental conditions is dependent on the host rack, it is the responsibility of the applicant to adapt DO-160 temperature high and low values and temperature variations cycle to the intended IMA module installation context. For example, in case of temperature testing (EUROCAE ED-14/RTCA DO-160 section 4.0), the temperature environment of the module (inside a rack) may be much higher or lower than the equipment level condition expressed in EUROCAE ED-14/RTCA DO-160 section 4.0. The applicant may therefore qualify their IMA module based on a chosen intended environment, and, finally, indicate in the installation manual the temperature range for which the good operation of the IMA module is guaranteed.
Altitude	4.6	Mandatory
Temperature Variation	5.0	Mandatory As for section 4.5, when module performance over environmental conditions is dependent on the host rack, it is the responsibility of the applicant to adapt DO-160 temperature high and low values and temperature variations cycle to the intended IMA module installation context. As for section 4.5, for example, in case of temperature testing (EUROCAE ED-14/RTCA DO-160 section 4.0), the temperature environment of the module (inside a rack) may be much higher or lower than the equipment level condition expressed in EUROCAE ED-14/RTCA DO-160 section 4.0, the applicant can qualify their IMA module based on a chosen intended environment, and, finally, indicate in the installation manual the temperature range for which the good operation of the IMA module is guaranteed.

Environmental Test	ED-14/ DO-160 section	Requirement for ETSO-2C153
Humidity	6.0	Mandatory
Shock (operational)	7.2	Optional
Shock (Crash Safety)	7.3	Optional
Vibration	8.0	Optional Note: the IMA module technology should be assessed for further DO-160 vibration qualification. This assessment could consider the IMA module components technology diversity, integration density and number of layers of the circuit boards within the IMA module. The assessment could be confirmed with testing on a module representative of the IMA module technology used in the product under certification.
Explosion Atmosphere	9.0	Optional
Waterproof	10.0	Optional
Fluids Susceptibility	11.0	Optional
Sand and Dust	12.0	Optional
Fungus Resistance	13.0	Optional
Salt Fog	14.0	Optional
Magnetic Effect	15.0	Optional
Power Input	16.0	Mandatory for IMA module interfaces directly connected to aircraft power distribution. Note: IMA module interfaces not directly connected to aircraft power distribution will be tested after cabinet integration phase as part of another ETSO application or as part of a Type-Certification programme.
Voltage Spike	17.0	Mandatory for IMA module interfaces directly connected to aircraft power distribution. Note: IMA module interfaces not directly connected to aircraft power distribution will be tested after cabinet integration phase as part of another ETSO application or as part of a Type-Certification programme.
Audio Frequency Conducted Susceptibility—Power Input	18.0	Mandatory for IMA module interfaces directly connected to aircraft power distribution. Note: IMA module interfaces not directly connected to aircraft power distribution will be tested after cabinet integration phase as part of another ETSO application or as part of a Type-Certification programme.
Induced Signal Susceptibility	19.0	Mandatory for IMA module interfaces directly connected to aircraft wiring. Note: IMA module interfaces not directly connected to aircraft wiring will be tested after cabinet integration phase as part of another ETSO application or as part of a Type-Certification programme.
Radio Frequency Susceptibility (Radiated and conduced)	20.0	Mandatory for conducted susceptibility of IMA module interfaces directly connected to aircraft wiring. Note: IMA module interfaces not directly connected to aircraft wiring will be tested after cabinet integration phase as part of another ETSO application or as part of a Type-

Environmental Test	ED-14/ DO-160 section	Requirement for ETSO-2C153
		Certification programme.
Emission of Radio Frequency Energy	21.0	Mandatory for conducted susceptibility of IMA module interfaces directly connected to aircraft wiring. Note: IMA module interfaces not directly connected to aircraft wiring will be tested after cabinet integration phase as part of another ETSO application or as part of a Type Certification programme.
Lightning Induced Transient Susceptibility	22.0	Mandatory for IMA module interfaces directly connected to aircraft wiring. Note: IMA module interfaces not directly connected to aircraft wiring will be tested after cabinet integration phase as part of another ETSO application or as part of a Type Certification programme.
Lightning Direct Effects	23.0	Optional
Icing	24.0	Optional
Electro Static Discharge (ESD)	25.0	Mandatory for all areas subject to human contact during IMA module operation.
Fire, Flammability	26.0	Mandatory

Figure 25 Environmental Qualification Testing minimum subset
for ETSO-2C153 in case of Cabinet architecture

Chapter 3: MPS compliance during Environmental Qualification Testing

When required by the test condition and procedure (by 'DETERMINE COMPLIANCE WITH EQUIPEMENT PERFORMANCE STANDARDS' statement), the IMA module manufacturer must determine compliance with the MPS as defined in column 'Test under environmental conditions' of each individual class in Appendix 2:

MPS CLASS	MPS paragraph under Environmental Qualification Testing
All Classes (Common)	Appendix 2.1 paragraph 5
RH (Rack)	This Appendix 4 is not applicable to this class. See Appendix 2.2 paragraph 6 columns 'Test Under Environmental conditions' and 'Applicable DO-160 sections'.
PR (Processing)	Appendix 2.3 paragraph 3
GP (Graphical Processing)	Appendix 2.4 paragraph 3
DS (Data Storage)	Appendix 2.5 paragraph 3
IF (Interface)	Appendix 2.6 paragraph 3
PS (Power Supply)	Appendix 2.7 paragraph 3
DH (Display Head)	Appendix 2.8 paragraph 3

Figure 26 - MPS verification under Environmental conditions

4. Regulatory Impact Assessment (RIA)

4.1. Issues to be addressed

4.1.1. Context

The use of Integrated Modular Avionics (IMA) is rapidly expanding and is found in all classes of aircraft, in the first place in large aeroplanes used for Commercial Air Transport (CAT), but also in large helicopters.

IMA is a shared set of flexible, reusable and interoperable hardware and software resources that, when integrated, form a 'platform' that provides services, designed and verified to meet a defined set of safety and performance requirements and to host applications performing aircraft functions.

These IMA architectures are integrating on the same platform many aircraft functions, provided by several software applications that have historically been contained in functionally and physically separated 'boxes' or Line Replaceable Units (LRUs).

These platforms are composed of modules which are designed to be reusable in order to reduce cost development and facilitate certification programmes. Some platforms provide only mechanical, possibly thermal and electrical power supply functions. Others include core software and associated memory and processing capabilities.

The IMA modules are both generic and configurable and therefore the same platform can be used on a number of different aircraft models.
Current Regulatory and Interpretative MaterialDuring the last 10 years, for certification programmes involving IMA, various EASA Project Certification Teams have defined Certification Review Items (CRI) as Interpretative Material (IM) dedicated to IMA, specific for each Certification Programme.

In these CRI, the EASA team considered the IMA architecture as a complex system of the aircraft and has required that the related development, validation, verification and certification activities should follow the requirements and guidelines of AMC 25.1309 and ED-79/ARP 4754.

These CRI have also addressed certification procedures for such modular systems, providing guidelines to manage credit that can be built progressively from the incremental approval of components for the IMA system.

Since 2007, DO-297/ED-124 (Integrated Modular Avionics Development Guidance and Certification Considerations) have also been available. These documents provide guidance for IMA developers, integrators, applicants, and those involved in the approval and the continuing airworthiness of the IMA systems.

4.1.2. Issues

Current material in the EASA system are:

— Programme-specific (CRI as Interpretative Material) and therefore confidential and not available through the web to other interested parties ;

— Focussing on the IMA system integration and approval in the frame of Type-Certificate (or Supplemental Type Certificate) at aircraft level (and therefore not directly allowing approval of the platform design independently of the aircraft).

In other words, whereas IMA platforms are composed of modules which are designed to be reusable on several aircraft models, being aircraft-independent, there is currently no publicly available regulatory or advisory material. This, in turn, does not allow the industry to obtain an ETSO authorisation for the design of these generic modules, so creating a commercial disadvantage to European avionics manufacturers building avionics product lines based on IMA architecture. Without the ETSO Authorisation, manufactures cannot sign 'EASA Form 1', which is instead appreciated by buyers all around the world.

On the other side, US manufactures also experience difficulties when offering IMA platforms to EU aircraft designers, due to the present inconsistencies of the two regulatory systems (FAA TSO 6C153 was published in 2002).

The above is not in line with the mission given by the legislator to EASA in Article 2 of the Basic Regulation and in particular with some letters in paragraph 2.2 therein:

(b) to facilitate the free movement of goods, persons and services;

(c) to promote cost-efficiency in the regulatory and certification processes;

(f) to provide a level playing field for all actors in the internal aviation market.

4.1.3. Safety risk assessment

Today there is no evidence that IMA, if integrated following the principles in AMC to CS-XX.1309, is less safe that traditional avionics 'boxes', which contained e.g. their mechanical mounting parts, their respective power supply, processing resources, etc.

4.1.4. Who is affected?

The stakeholders involved in the airworthiness approval of IMA are mainly Design Organisations and Production Organisations both at aircraft level and at equipment level.

More in particular other affected stakeholders are:

— Certification Authorities (i.e. EASA for aircraft whose design is in its scope[7]);

— Applicants/Holders of Type-Certificates (TC) or Supplemental TC (STC) for the aircraft;

— IMA System Integrators;

— Application Suppliers[8];

— Platform and Module suppliers.

4.1.5. How could the issue/problem evolve?

The continuing existence of the highlighted regulatory 'gap' of the Agency in comparison with the US FAA would continue to penalise industry (European in the first place, but also IMA manufacturers around the world) and require more effort for the Agency during the certification process.

The situation would progressively become worse, since the cost, mass and volume benefits achievable through IMA will without doubt be applied to a significant number of future aircraft types or variants.

---

[7] As defined in Articles 1 and 4 and in Annex II to the Basic Regulation 216/2008.

[8] According to Article 3(d) of the Basic Regulation, as amended by Regulation 1108/2009, an aircraft 'part' is any instrument, equipment, mechanism, part, apparatus, appurtenance, software or accessory, including communications equipment, that is used or intended to be used in operating or controlling an aircraft in flight; in other words, a simple software module can be considered an aircraft part.

4.2. Objectives

This proposal will specifically contribute to the achievement of the overall objectives, given by the Legislator to the Agency in Article 2 of the Basic Regulation, by paving the way for cost-efficient and transparent certification process by offering to IMA manufacturers the possibility to obtain ETSO authorisations at platform/module level, independent of aircraft.

4.3. Policy options

The following policy options have been identified:

Table 2: Selected policy options

Option No	***Short title***	**Description**
0	'Do nothing'	Baseline option (no change in rules; issues remain as outlined in the above analysis).
1	No MPS	Follow the approach of FAA TSO C153 (no Minimum Performance Requirements (MPS) in ETSO-2C153) and therefore address performance during integration at aircraft level. No link between aircraft certification projects and ETSO authorisation.
2	Deferred ETSOA	Follow the approach of FAA TSO C153 (no Minimum Performance Requirements (MPS) in ETSO-2C153) and therefore address performance during integration at aircraft level. But also grant ETSO authorisation only after IMA equipment has been accepted in the context of a TC/STC project.
3	MPS	Publish ETSO-2C153 on 'IMA platform modules' (based on FAA C153 but introducemodifications, in particular MPS for various IMA Classes). No link between ETSOA and any (S)TC project. After the ETSO authorisation, the IMA components could be used during (S)TC projects without demonstrating the IMA performances (i.e. giving 'credit' to the ETSOA).
4	Intermediate integration	In addition to Option 3, provide, in the future, guidance in CS-ETSO Subpart A, for integration of two or more ETSO articles (e.g. IMA platform and at least one aircraft function, e.g. autopilot) before installation in the aircraft.

Option 4 is not analysed in detail in the following paragraphs, since it is covered by RMT.0621.

4.4. Methodology (MCA)

The first step (ref. paragraph 4.3 above) is to identify possible alternative options, where the first one (Option 0) does not introduce any new or amended rule ('do nothing').

The options to be analysed in detail (four in this NPA) are then comparatively assessed in terms of safety, environmental, social and economic impacts, as well as proportionality and harmonisation.

All identified impacts are qualitatively assessed (RIA light) and expressed as a score, which is a numerical single digit. This is the principle of the Multi-Criteria Analysis (MCA) which allows translating any assessment (qualitative or quantitative but not in the same units of measurement) into a non-dimensional numerical score, as in the table below:

Table 3: RIA unweighted scores

Scale for assessment of impacts	Score
Highly positive (High)	+5
Significantly positive (Medium)	+3
Slightly positive (Low)	+1
Neutral	0
Slightly negative (Low)	-1
Significantly negative (Medium)	-3
Highly negative (High)	-5

Safety scores, since safety is the primary objective of the Agency as per Article 2 of the Basic Regulation, are assigned a weight of 3. Environmental scores, based on the same Article, have a weight of 2. Other scores' weight is 1.

Finally, all these scores are algebraically summed.

Significant differences in these final weighted scores support the decision on the option to be preferred.

4.5. Analysis of impacts

4.5.1. Safety impact

The four analysed options can be compared from the safety perspective in the table below:

Options	**0**	**1**	**2**	**3**
	Do nothing	**No MPS**	**Deferred ETSOA**	**MPS**
Assessment	Uniform safety may not be achieved across different aircraft certification projects, due to the lack on common and publicly available regulatory material	Issuing ETSO authorisations, without having demonstrated any minimum performance, may lead to superficial assessment at aircraft level and therefore be detrimental to safety	The ETSO authorisation would be issued only once a thorough safety assessment is carried out at aircraft level	A thorough safety assessment is carried out at equipment level. From the safety perspective equivalent to Option 2
Score (unweighted)	–1	-3	3	3
Weight	Multiply the unweighted score by: 3			
Score (weighted)	**–3**	**-9**	**9**	**9**

4.5.2. Environmental impact

The four analysed options can be compared from the environmental perspective in the table below:

Options	**0**	**1**	**2**	**3**
	Do nothing	**No MPS**	**Deferred ETSOA**	**MPS**
Assessment	Slower spreading of the IMA concept across the fleet and hence more total mass of the aircraft, which in turn leads to more emissions	Accelerated spreading of the IMA concept, with gains in terms of reduced aircraft mass and hence less emissions	Beneficial, but less than Option 1, since the ETSOA would be more difficult to be applied to different aircraft types	As Option 1
Score (unweighted)	–1	3	1	3
Weight	Multiply the unweighted score by: 2			
Score (weighted)	**–2**	**6**	**2**	**6**

4.5.3. Social impact

The four analysed options can be compared from the social perspective in the table below:

Options	**0**	**1**	**2**	**3**
	Do nothing	**No MPS**	**Deferred ETSOA**	**MPS**
Assessment	Loss of a number of qualified jobs in European industry, due to its loss of competitiveness	Increase of the competitiveness of the EU industry, which would align with the US industry	Beneficial, but less than Option 1, since the ETSOA would be more difficult to be applied to different aircraft types	Even better than Option 1, since the Agency's rules would be more modern than the corresponding FAA ones, and therefore other States may with the EU ETSO
Score (unweighted)	–1	3	1	5
Weight	Multiply the unweighted score by: 1			
Score (weighted)	**–1**	**3**	**1**	**5**

4.5.4. Economic impact

The four analysed options can be compared from the economic perspective in the table below:

Options	**0**	**1**	**2**	**3**
	Do nothing	**No MPS**	**Deferred ETSOA**	**MPS**
Assessment	Loss of competitiveness for the EU industry on the worldwide market	Alignment of the competitiveness of the EU industry, from the administrative point of view, with the US industry	Beneficial, but less than Option 1, since the ETSOA would be more difficult to be applied to different aircraft types	Agency provision more modern than the corresponding FAA ones would facilitate export. A number of authorities may also decide to apply the Agency's approach
Score (unweighted)	–3	3	1	5
Weight	Multiply the unweighted score by: 1			
Score (weighted)	**–3**	**3**	**1**	**5**

4.5.5. General aviation and proportionality issues

Since the application for an ETSO Authorisation is voluntary and since the existence of ETSO-2C153 does not oblige aircraft manufacturers to implement IMA, at first glance the four analysed options may seem equivalent.

However, the existence of an ETSO Authorisation, and the related "credit" during aircraft certification, may facilitate the spreading of IMA towards lighter airframes, including aircraft produced by SMEs.

The four analysed options can hence be compared from the proportionality perspective in the table below:

Options	**0**	**1**	**2**	**3**
	Do nothing	**No MPS**	**Deferred ETSOA**	**MPS**
Assessment	More difficult to implement IMA by SMEs on lighter aircraft	As 0, since the burden to demonstrate performance would remain at aircraft level	As 0, since the burden to demonstrate performance would remain at aircraft level	Implementation of IMA on lighter aircraft significantly facilitated
Score (unweighted)	–3	-3	-3	3
Weight	Multiply the unweighted score by: 1			
Score (weighted)	**–3**	**-3**	**-3**	**3**

4.5.6. Impact on 'Better Regulation' and harmonisation

IMA is not covered by any ICAO provision and therefore all analysed options are neutral in comparison to ICAO.

However, the proposed ETSO-2C153 would be significantly different from the corresponding FAA TSO, published more than ten years ago.

The adoption of said ETSO would however contribute to better regulation since:

- its application is voluntary;
- it allows manufacturers to include one or more IMA modules in respective designs (maximum flexibility);
- it allows buyers of IMA platforms to clearly and transparently understand which minimum performances are guaranteed; and
- it contributes to facilitation of certifications at aircraft level, without duplication of processes or confusion of responsibilities.

The four analysed options can hence be compared from the harmonisation perspective in the table below:

Options	**0**	**1**	**2**	**3**
	Do nothing	**No MPS**	**Deferred ETSOA**	**MPS**
Assessment	Neither aligned with 'better regulation', nor harmonised with the FAA	Partially aligned with FAA approach, but not with the transparency and clarity demanded by 'better regulation'	Totally aligned with FAA approach, but not with the transparency and clarity demanded by 'better regulation'	More modern than corresponding FAA provisions, but fully aligned with 'better regulation'
Score (unweighted)	–5	-3	-1	1
Weight	Multiply the unweighted score by: 1			
Score (weighted)	**–5**	**-3**	**-1**	**1**

4.6. Comparison and conclusion

4.6.1. Comparison of options

Using the multi-criteria analysis (MCA) methodology, the 'weighted' scores assigned above are algebraically summed:

Options	0	1	2	3
	Do nothing	No MPS	Deferred ETSOA	MPS
	Weighted score			
Safety	–3	-9	9	9
Environment	–2	6	2	6
Social impact	–1	3	1	5
Economic impact	–3	3	1	5
Proportionality	–3	-3	-3	3
Regulatory harmonisation	–5	-3	-1	1
TOTAL	**-17**	**-3**	**9**	**29**

Option 0 ('do nothing') has a significantly negative total score, while being also slightly negative from the safety perspective.

Option 1 (i.e. 'copy and paste' FAA TSO-C153, so not including minimum performance requirements) is the most negative in safety terms, while it has ving a slightly negative total score. Even if harmonised with FAA TSO, it is not even positive from the regulatory harmonisation perspective, since it is diverging from the principles of the EU 'better regulation'.

Option 2 (i.e. apply totally the US approach and issue the ETSOA only after performance and safe integration have been demonstrated at aircraft level) is overall positive, but not from the proportionality and harmonisation (again reference to 'better regulation') perspective.

Finally, Option 3 (publish ETSO-2C153 in Index 2 of CS-ETSO and include in it minimum performance specifications), has a very high total score and is significantly positive from the safety, environmental, social and economic point of view, while not being negative from the other perspectives. It is hence the preferred option.

5. References

5.1. Affected regulations

No EU Regulations are affected by this NPA.

5.2. Applicable regulations

Commission Regulation (EU) No 748/2012 of 3 August 2012 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations (Part-21).

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:224:0001:0085:EN:PDF.

5.3. Affected CS

Decision 2003/10/RM of the Executive Director of the European Aviation Safety Agency of 24 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for European Technical Standard Orders (CS-ETSO).

http://www.easa.europa.eu/document-library/certification-specifications?search=CS-ETSO&date_filter%5Bmin%5D%5Bdate%5D=&date_filter%5Bmax%5D%5Bdate%5D=&=Apply.

5.4. Affected AMC and GM

No AMC or GM are affected by this NPA.

5.5. Reference documents

a) FAA TSO-C153 on Integrated Modular Avionics Hardware Elements, of 5 June 2002 http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgTSO.nsf/0/c07999442e496ada86256dc700717db5/$FILE/C153.pdf.

b) FAA Advisory Circular AC 20-170 of 28 October 2010 (including change 1) on Integrated Modular Avionics development, verification integration and approval, using RTCA DO-297 and TSO-C153.

http://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_20-170_w-chg_1.pdf.

c) Eurocae ED-124 of June 2007 on Integrated Modular Avionics (IMA) development (guidance and certification considerations).

Eurocae ED-12C of January 2012 on Software Considerations in Airborne Systems and Equipment Certification.